JOURNAL of the Russell Society

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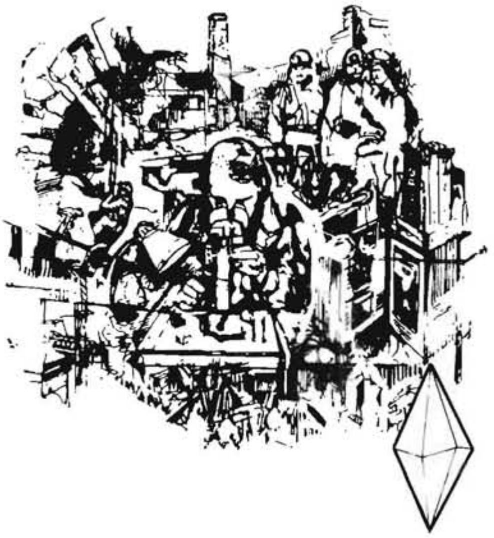

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COVER PHOTO Malachite on Chalcopyrite, on Dolomite from Ty Gwyn Mine Llandudno

THE JOURNAL OF THE RUSSELL SOCIETY

EDITORIAL

On the 27th October 1972 a group of people came together to inaugurate a new society – a society designed to serve the interests and aims of amateur mineralogists, at first at a local level, but ultimately at a national level.

Perhaps the most eminent amateur mineralogist of the 20th century was the late Sir Arthur Russell. Arthur Edward Ian Montagu Russell, 6th Baronet, of Swallowfield Park, Reading, in Berkshire, was born on the 30th November 1878, the second son of Sir George Russell, 4th Baronet, and succeeded to the title on the death of his elder brother George Arthur Charles Russell in 1944.

It was from his mother Lady Constance Russell that Sir Arthur acquired his love of minerals. Lady Russell had herself been a keen student of mineralogy and had built a considerable collection of minerals which she gave to her son Arthur. This collection formed the nucleus of what was to become, under Sir Arthur's hands, the most remarkable and comprehensive collection of British minerals ever made. During the course of his lifetime's work Sir Arthur visited and collected from almost every mine in Great Britain and Ireland, and went underground in every metalliferous mine in the British Isles which had been worked in his lifetime.

As a field mineralogist, Sir Arthur was outstanding. He had a keen eye, especially for the rarer species and possessed an almost instinctive understanding of mineralogical environments and where minerals might be found.

Though often found working alone, he made friends easily and counted amongst them miners and quarrymen. His generosity and kindness to young budding mineralogists was legendary, and his infectious enthusiasm and great knowledge of his subject was an inspiration to all who met him. A visit to his home at Swallowfield Park was an unforgettable experience where the warmness of the welcome and the kindness and skill in promoting the interest of a young visitor was a mark of the great man.

In addition to his own able collecting, Sir Arthur had acquired the whole or part of many important collections, some dating back to the 18th century. It was typical of the man that he would generously give mineralogical material he possessed if he believed the specimens would be of more value to the recipient than himself.

When seeking a title for the new society, it was unanimously agreed with the kind consent of Lady Russell, that no better name could be chosen than the Russell Society. In this way it was hoped that Sir Arthur's memory would be perpetuated, and the members might be inspired to strive to achieve the high mineralogical ideals which Sir Arthur followed in his lifetime.

Now after 9 years of growth the committee hopes and believes that Sir Arthur would approve of the activities of this society named after him, and would give his blessing to this new venture – a journal in his name.

In the society the need for such a journal has long been felt where accomplished amateur mineralogists might present scientifically important observations, both on systematical and topographical mineralogy they may have, and which might be unacceptable to the current professionally orientated scientific journals.

The academic standard of the new journal will, it is hoped, equate with that of the Mineralogical Record, with the exception of coloured plates. It is hoped there will be a bias to British topographical mineralogy, but foreign articles of a similar nature would be welcome.

Sir Arthur died on the 23rd February 1964 at the age of 86. It is hoped that his death does not, as the writer of his obituary stated, mark the end of an era, and that his memory, perpetuated by his lifetimes' work in the form of his collection, and by the work of the Russell Society, might promote the development of another giant in the field of amateur mineralogy.

Dr. R.J. King

CONTENTS

BARYTE AND OTHER MINERALS FROM THE ISLE OF SHEPPEY, KENT

Paul K. Monk

Introduction

The north coast of the Isle of Sheppey, Kent, has long been known for its minerals and fossils. The mineral that is of most interest there is Baryte. This was recorded and illustrated by Sowerby (1817) and by Greg and Lettsom (1858). Other minerals occurring are calcite, pyrite, gypsum (variety selenite), and unidentified iron oxides. The area is also a classical locality for an Eocene flora and fauna. A wide variety of vertebrates, invertebrates and plant fossils may be collected, although with some difficulty. Reid and Chandler (1933) brought together the work of many dedicated collectors in the field.

Location

Warden Point (Natn. Grid Ref. TR 0272) is on the north coast of the Isle of Sheppey, a generally low lying island off the north coast of Kent.

Access to the cliffs and beach can be difficult and even dangerous. (There have been fatalities on the mudflows.) However, a gully to the West of the Coastguard Station can give access to the beach.

Geology

The geology of the referenced area consists of lower Eocene deposits made up largely of the upper beds of the London Clay, thinly capped in the north by sandy beds of the Bagshot Sands.

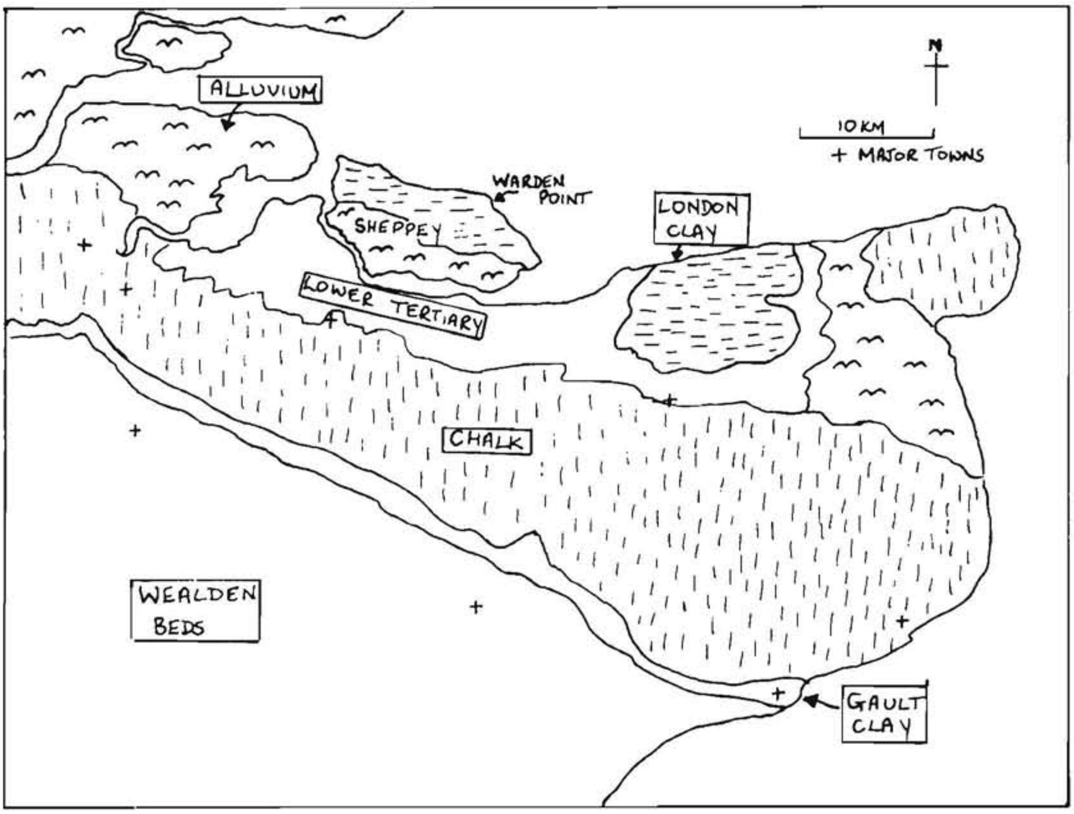

Fig. 1. Geological sketch map of East Kent

The London Clay, blue when unweathered, but turning brown on exposure, is rich in septarian nodules. The latter vary greatly in size, from 100 mm to over a metre in diameter, and the beach is littered with weathered out nodules.

The author refers the reader to Pitcher, et al. (1967) for greater detail of the geology.

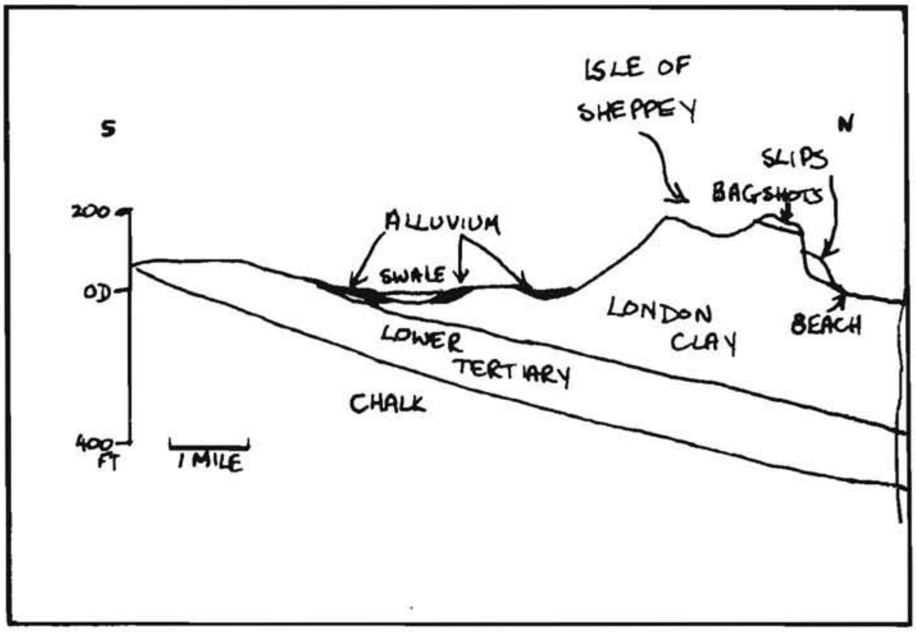

Fig. 2. Geological sketch across the Isle of Sheppey. (After Wrigley, A., in Davis, 1936)

Mineralogy

The following minerals occur in the septarian nodules:

(a) Calcite

Calcite occurs as a yellow or green lining to the cracks in the septarian nodules, and can show drusey linings of very small crystals. It does not fluoresce under ultra-violet light and it is possible that the high pyrite content of the calcite is a factor in this.

(b) Baryte

The baryte occurs as radiating acicular sprays of terminated crystals which may attain 50 mm in diameter. It occurs only in the calcite-lined cracks of the septarian nodules upon which it is deposited. It strongly fluoresces white under both wavelengths of ultraviolet light.

Baryte at Sheppey occurs in two crystallographic habits, called here type A and type B.

Type A:
This is the common form. Each baryte crystal is acicular with smooth prism faces and good terminations. These crystals are transluscent and greenish-grey in colour.

Type B:
This type is much rarer. These crystals are white, tabular with serrated prism faces. They represent several distinct phases of crystal growth.

(c) Pyrite

Pyrite is common throughout the clay. Two habits may be observed, the most common being that of fossil replacement – the less common as microcrystalline masses. Both may be found on the beach where they have been gravity-sorted by the sea. Most of Reid and Chandler's (1933) long faunal and floral lists comprise this kind of material. Rarely, cubic crystals can be found. These occur in some septarian nodules dispersed on calcite and in fossil wood bored by Teredina. Due to its microcrystalline nature the pyrite is metastable and is of importance in the formation of the next mineral.

(d) Gypsum (var. Selenite)

Selenite appears to be of very recent origin and it is possible that it is being formed at the present day. It occurs as small crystals tabular on $\{010\}$, or as larger crystals twinned on $\{\bar{1}01\}$. The selenite is colourless and transparent, but larger crystals have inclusions of clay which depict the growth lines.

The origin of the selenite appears to conform to the following process:

$$H_2SO_4 + CaCO_3 \longrightarrow CaSO_4 + CO_2 + H_2O$$

The H_2SO_4 is formed in the weathering of the pyrite and the calcite appears to have been derived from fossil shells rather than from the septarian nodules.

(e) Unidentified Iron Oxides

These occur as white, yellow and reddish powdery masses in the clay. They are the weathering remains of pyrite nodules. Their species identification is unknown, but natrojarosite has been reported from the Isle of Sheppey (Personal communication; RJK).

DISCUSSION

The origin of the baryte at this locality is problematical. As far as can be ascertained, barium minerals are not found anywhere else in the London Basin, though it does occur in the Cretaceous of Nutfield in Surrey.

It appears that most of the baryte occurs in the uppermost beds of nodules that lie only a few feet below the base of the Bagshot Sands, although this observation needs further field and laboratory work to verify it. Since the Bagshot Beds form an obvious aquifer it is possible that the barium-rich solutions migrated downwards finding favourable conditions for crystallization as baryte in the septarian nodules. A careful analysis of the barium content of the clay may show a decline in values with depth. Such an analysis has not been attempted. Alternatively, it is possible that the barium is evenly distributed throughout the clay, thus suggesting a contemporaneous origin with the clay, with some relocation of the baryte by processes of diagensis as shown by Hudson's work (1978).

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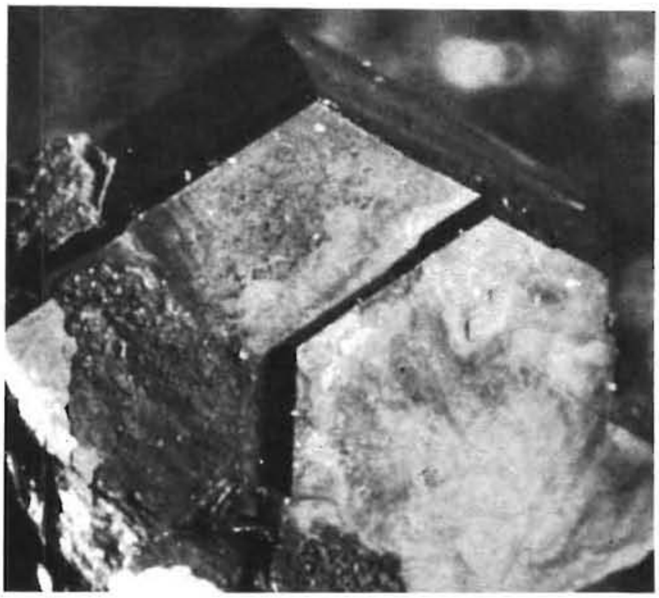

Hexagonal Pyrrhotine crystal (7mm across edges)

METAL MINES OF THE BRITISH ISLES No. 1

DYLIFE (Powys)

Situated in the very heart of Wales on the high road from Llanidloes to Machynlleth, lies the Dylife mine. Mining here, as with many Welsh mines, dates from Roman times, but mining really came to Dylife in the 1850's when greater investment brought with it greater productivity. In 1860, some of the most modern mining machinery in Britain found application here.

In the 1870's with the introduction of cheaper foreign ores and a fluctuating world price system, Dylife was forced to adopt cost saving measures with consequential production losses and a gradual decline, struggling on to eventually close in 1901.

The mine's greatest production years were between 1845 and 1901. Between these years it produced in total the following: 36,684 tons of lead, 1540 tons of copper, 391 tons of zinc and approximately 160,000 oz. of silver (Bick, 1977)

The workings at Dylife are centred on three lodes: The Dylife Lode coursing east-west, branches into two parallel lodes, the northern branch, the Esgairgaled Lode carried mainly zinc ore, but the other, the Llechwedd Ddu Lode (actually the eastern extension of the Dylife Lode) proved to be a very lead rich lode.

Most of the mining took place in the green mudstones of the Frongoch Formation (Silurian Llandoverian) although the deepest levels penetrated the black shales of the Gwestyn Form ation (Jones, 1922).

In recent years the extensive mine dumps have produced an impressive array of minerals including Wulfenite, Pyromorphite, Malachite, Azurite, Linarite, Hemimorphite, Chrysocolla, Cerussite, Brochantite, Aurichalcite, Serpierite, Native Copper, and nodular variety of Sphalerite consisting of hemispherical aggregates from 25 - 100mm in diameter with an internal radial fibrous structure. (Jones & Moreton, 1977). Greenockite is commonly found occurring as yellow globular crusts in cavities in Sphalerite and as fine yellow powdery coatings on Hemimorphite crystals.

Another interesting mineral has been noted on the large dump immediately below the Star Inn, here in a large block of vein Breccia were found superb examples of short prismatic hexagonal crystals of Pyrrhotine associated with Galena, Chalcopyrite and cubic crystals of Pyrite.

The Pyrrhotine was magnetic but of low intensity. (Jones, 1974). No doubt future research in the Dylife area will unearth other interesting minerals, Anglesite perhaps?

N.J.M. Moreton

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A NEW OCCURRENCE OF SCARBROITE IN BRITAIN

Dr. R.J. King

i. Abstract

A new occurrence of scarbroite is described geologically and mineralogically as occurring in "gulls" in the basal unit of the Northampton Sand Formation as pale orange-coloured nodules, at Weston Favell, Northamptonshire.

The geology and mineralogy of the type section at Scarborough in Yorkshire, is also described for comparative reasons, and the geological similarities of the two sections are discussed in the light of the possible genesis of both deposits.

It is suggested that the occurrence of scarbroite in Northamptonshire and Yorkshire is a periglacial feature and that both deposits have been formed in Pleistocene time.

ii. Introduction

Aluminium-rich minerals are relatively common in Jurassic lithologies, especially within the Middle Jurassic. For example, several divisions of the Northampton Sand Formation are rich in members of the kaolinite group (Taylor, 1949), and there have been numerous references to occurrences of other aluminium-rich minerals within other stages of the Middle Jurassic.

It is not surprising therefore that Northamptonshire has received its share of the distribution of such minerals. The rare aluminium-rich species basaluminite and hydrobasaluminite have been described from the Little Irchester area of Northamptonshire (Bannister and Hollingworth, 1948). Both these species have subsequently been identified from six other localities in the iron ore field of Northamptonshire (writer's personal observations). There are references to the occurrence of aluminium-rich minerals related to allophane, one, for example, in a pit opened in the grounds of the Northampton Mental Hospital (Natn. Grid. Ref. SP770600), where aluminium-rich clay minerals were found deposited on the surfaces of joints in the ironstone of the Northampton Sand Formation (Herman, 1871).

During a routine examination of major road works at Weston Favell (Natn. Grid. Ref. SP7861), now a suburb of Northampton, an aluminium-rich clay mineral was found in a "gull" or open solution joint in the Northampton Sand Formation, which has proved to be scarbroite. The occurrence of scarbroite at Weston Favell is remarkable not only because it presents a second British occurrence, the original locality being at Scarborough in Yorkshire (Vernon, 1829), but also because of its abundance and striking mode of occurrence.

The geology and mineralogy of the Weston Favell, and that of the type locality are described in detail below. Geological similarities between the two occurrences are described in an attempt to throw some light on the genetic mechanism of deposition of scarbroite.

Material from Weston Favell in the writer's collection is accessioned under numbers: K8183-72, K8184-72, and reserve material available for study under field number: K72-49.

iii. Geology of the Weston Favell occurrence

In 1972 the excavation of a deep cutting to accommodate the Lumbertubs to Wellingborough Road phase of the new transverse distributor road system – Lumbertubs Way, at Natn. Grid. Ref. SP795625, exposed a fine section through the Upper Lias (Toarcian, Lower Jurassic) and the lowest division of the Northampton Sand Formation (Aalenian, Middle Jurassic), with the variable thickness of overlying Pleistocene deposits.

The Upper Lias consisted of approximately 5m (seen) of dark to medium grey calcareous mudstones with scattered calcareous nodules. The abundant fauna was typical of the **Hildoceras bifrons** Zone (Toarcian) of Northamptonshire. Apart from the occurrence of abundant gypsum crystals (both single and twinned) and minor amounts of pyrite and sphalerite (in the nodules), there was nothing of structural or mineralogical interest.

The Aalenian (Lower Bajocian **sensu anglico**) however, consisted of approximately 4m of strongly jointed and mineralized ferruginous calcareous sandstones and sandy limestones. These beds are the lower part of the Northampton Sand Formation, i.e. they belong to the Lower Siderite Mudstone-Limestone Group of Taylor (1949, p.12). They were patchily fossiliferous with brachiopods, crinoid ossicles and abundant plant debris. Where fresh, the rocks were light grey or pale chocolate brown, but along joints and bedding planes there had been much oxidation and movement of iron to produce limonitic "boxstone" type structures. Some of the joints had been opened by subsequent weathering processes in the form of "gulls". (Fig. 1.).

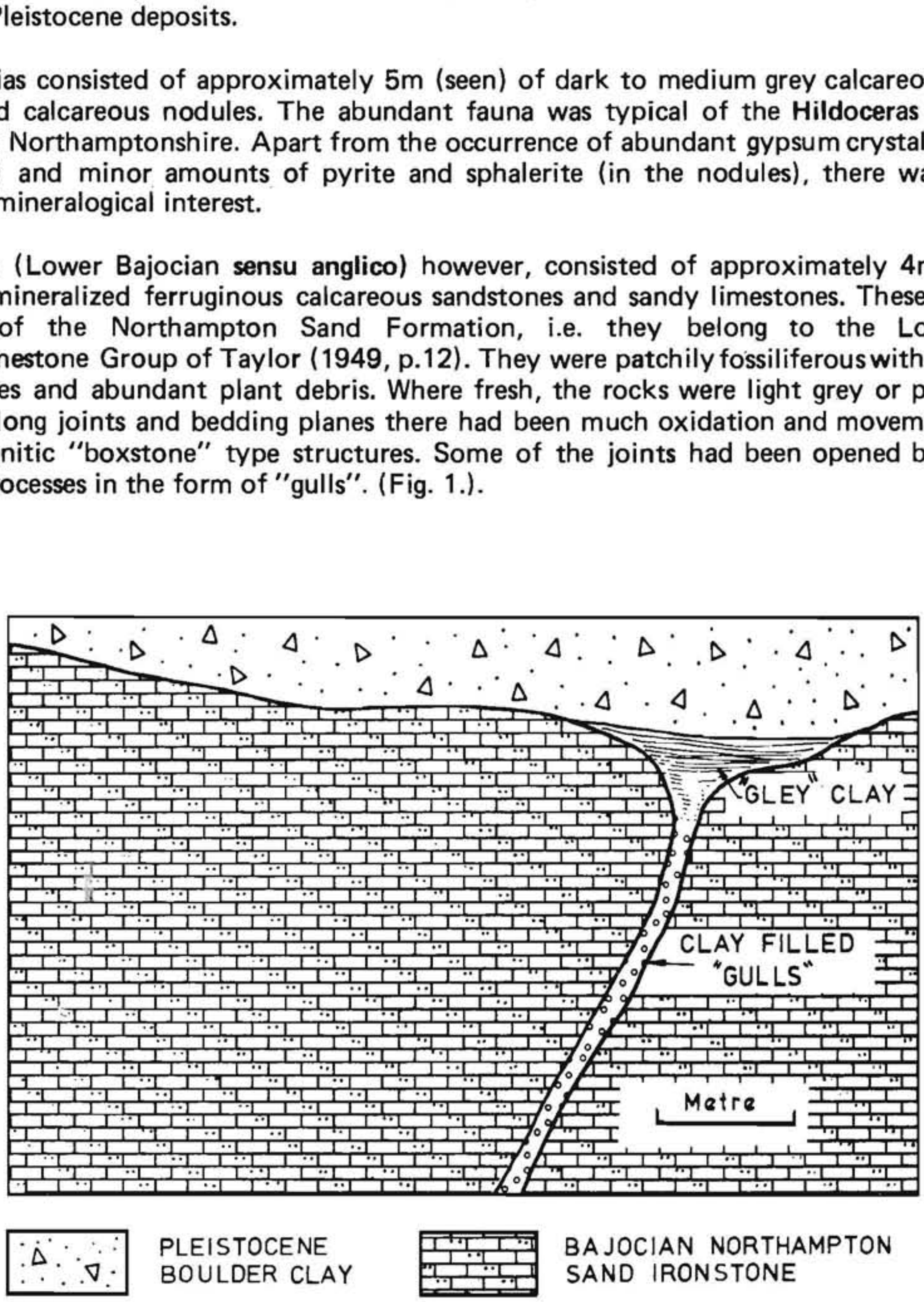


Figure 1. Diagrammatic sketch of a temporary exposure on the Lumbertubs – Wellingborough road at Weston Favell. The sketch shows the lowest unit of the Northampton Sand Ironstone overlain unconformably by stoneless and boulder clays of the Pleistocene, and cut by an enlarged joint or "gull", filled with sandy ferruginous and limey debris and nodules of scarbroite.

Unconformably overlying the Northampton Sand Formation was an average thickness of 2.6m of boulder-clay and stoneless clay of the Pleistocene. The presence of flints in the boulder clay suggested that it may have been Chalky Boulder Clay. The stoneless clays were stratified blue and dark green gley clays, resembling kettle-hole fills, and lay above and were warped down into the funnel shaped tops of the "gulls" in the Northampton Sand Formation beds below. The fact that these gley clays overlay the latter suggests that the"gulls" were the result of weathering under periglacial conditions.

One of the "gulls" observed during a visit made on 30th August 1972, was 3.2m in length, an average 140mm in width, and occupied a vertical open joint striking 258° E. Its base was not exposed in the observed section. Nowhere was the jointing observed in the Northampton Sand Formation seen to enter the Upper Lias clays below.

The walls of the "gull" were lined with a brown ferruginous sandy deposit which showed traces of cross bedding. The "gull" fill consisted of sandy material with sub angular, corroded sandy and oolitic limestone clasts up to 65mm in length. Dispersed throughout the fill were pale orange-coloured sub sphaeroidal masses up to 60 mm in diameter of scarbroite.

The only comparable geological section in the immediate environs of the Lumbertubs Way section was that found in the wells sunk for water on the site of the former Weston Favell House, now a hospital, immediately south of the A43 trunk road at Natn. Grid. Ref. SP777636 (Woodward and Thompson, 1909, p.165). Well No. 2 "bottomed" at 26m in Upper Lias clays after entering the Northampton Sand Formation at 23.7m from the surface, which lies topographically much higher than the Lumbertubs Way section.

iv. The Geology of the occurrence at Scarborough

Vernon (1829, p.178) first described the occurrence of a mineral new to science which he named: Scarbroïte from the locality where he found it at Scarborough on the Yorkshire coast. Stratigraphical nomenclature used in the description of the geology of Yorkshire may at first sight be confusing to a mineralogist seeking Vernon's type locality. Names of formations have changed over the years as research has advanced. Indeed Vernon's original description of the geology bore no stratigraphic terminology. In this scarbroite was described as occurring in the form of veins in "sandstone much marked by oxide of iron", (now known as the Scalby Formation), overlying "Calcareous rocks corresponding with the great oolite". (Now known as the Scarborough Formation).

Phillips (1829, p.123) referred to Vernon's work on scarbroite, also without stratigraphic terminology. He described the scarbroite-bearing veins which occur in the Scarborough Formation as "long straight intersecting fissures often lined with double laminae or septa of oxide of iron", in between which the scarbroite was deposited. He also observed that "exactly similar septa occur (red) in the superincumbent variable beds of sandstone (Scalby Formation).

Greg and Lettsom (1858, p.447), noted Phillips' description, and this may unfortunately have lead to confusion. Greg and Lettsom's Manual of the Mineralogy of Great Britain and Ireland (1858), has been used by many generations of mineralogists as virtually the only text book available of British topographical mineralogy. They correctly quote Phillips' description (1829), of Scarbroite occurring between septa, but use the term "ironstone" instead of "oxide of iron", which could imply, if the term septa was also misinterpreted, the occurrence of scarbroite in septarian ironstone nodules. The confusion was augmented by Dana (1892 p.694) who employed the term "Septarian". The term septum is now restricted to the biological connotation, the term septaria to the geological implying a structure anologous to that seen in septarian nodules. White clays resembling scarbroite do occur in the septarian nodules which occur in the Scarborough Formation, but these have now been positively identified as dickite (R. Tayler – personal communication).

In 1892, Fox-Strangways (p. 475) used the relatively new stratigraphic terminology to describe the occurrence at Scarborough, stating that scarbroite occurred principally in the upper part of the Grey Limestone (Scarborough Formation) and in the Estuarine Series (Scalby Formation) above, "in small veins lining the joints and fissures which traverse the rock in various directions".

The term Grey Limestone was first used by Wright (1860, p.17), but the stratigraphy was confused by Hudleston's introduction in 1874, (p. 311), of the synonym: the Scarborough Limestone. The stratigraphic unit was subsequently referred to as the Scarborough or Grey Limestone Series.

The term Upper Estuarine Series first appeared in print in 1880 (Fox-Strangways, p.3).

In 1945, Arkell, in 1974, Hemingway, and more recently Parsons (1980, p.3) and Torrens (1980, p.42) in Cope **et** al. (1980), rationalized the Jurassic stratigraphy of Yorkshire. The marine unit, formerly known as the Scarborough or Grey Limestone Series became the Scarborough Formation (Lower Bajocian) and the non-marine unit, formerly known as the Upper Estuarine Series became the Scalby Formation (Bajocian (?) Bathonian). These two units form the upper division of the Ravenscar Group of the Middle Jurassic of Yorkshire.

In 1980 the writer visited Vernon's section at Scarborough, using the more precise localisation of South Bay, Scarborough, given by Duffin and Goodyear (1957, p. 977), and 1960, p.353). The section exposed immediately to the north of White Nab in South Bay (Natn. Grid. Ref. TA 057865) including the southerly extremity of Black Rocks was examined. The Scarborough Formation here forms a strong feature on the foreshore. Its variable lithologies consist of sandstones and sandy limestones with siderite mudstone septarian nodules. Almost at the base of the cliff the non-marine Scalby Formation was exposed, with the quartzose sandstone of the Moor Grit member at its base (Sylvester-Bradley, 1949, p.22). Much of the section was obscured by slumped Boulder Clay which constituted the upper part of the cliff. (Plate 1).

Veinlets bearing deposits of scarbroite were most strongly developed in the Scalby Formation, and although they were seen to extend below into the Scarborough Formation, this was poorly exposed. The veins were largely restricted to vertical joints in the sandstones and were, on average 6mm in width (Plate 2).

The large majority were lined by a dark brown ferruginous fine-grained sandy material. They obviously still serve as conduits for surface groundwater, for in some the scarbroite was soft and wet.

Unlike Weston Favell, the contact relationships between the mineralized joints and the overlying Pleistocene deposits was not obvious, but in two cases the joints were seen to thicken towards the top of the section immediately underlying the unconformity between the Scalby Formation and the overlying Boulder Clay. The joints at this point carried no scarbroite and were filled with sandy ferruginous material.

v. **The mineralogy of the Weston Favell** occurrence

The mineralogical contents of the "gulls" in the Lumbertubs Way section at Weston Favell is obviously complex and the whole mineralogical story must here be incomplete.

The most striking feature of the occurrence is, however, the occurrence of scarbroite, which stands out from the sandy matrix of the "gulls" as nodular masses up to 65mm in length (Plate 3). The smaller nodules are almost spherical in shape, but this uniformity is lost as the size increases. The nodules are soft (H.1), though compact and have to be broken by a hammer. They are surrounded by a pellicle of soft powdery material thought to be hydroscarbroite. The colour of the nodules is uniformly a pale orange (5A3)$_1$, whereas the surrounding pellicles are yellowish white (3A2).

Preliminary qualitative analysis of material from the hard centre of a nodule confirmed the abundant presence of Al_2O_3, but the presence of silica and carbonate from uncontaminated material, raised doubts in the writer's mind as to its specific identification. Similar material was therefore sent to the British Museum (Nat. Hist.) for examination, which resulted in the positive identification of scarbroite by x-ray diffraction methods (B.M. x-ray No. 18469). A line pattern produced from this film, was strongly compatible with that given by Duffin and Goodyear (1960) on material supplied to the British Museum (Nat. Hist.) by those authors – B.M. x-ray film No. 8900.

Prelimary chemical work on the Weston Favell scarbroite proved that the hard nodular material strongly disintegrated following initial swelling and vigorous effervescence in concentrated hydrochloric and nitric acids, finally becoming a gel within a minimum of 19 days. There was no observable change upon immersion in water or in concentrated sulphuric acid for the same period.

Footnote 1: Methuen Handbook of Colour, 2nd Ed.

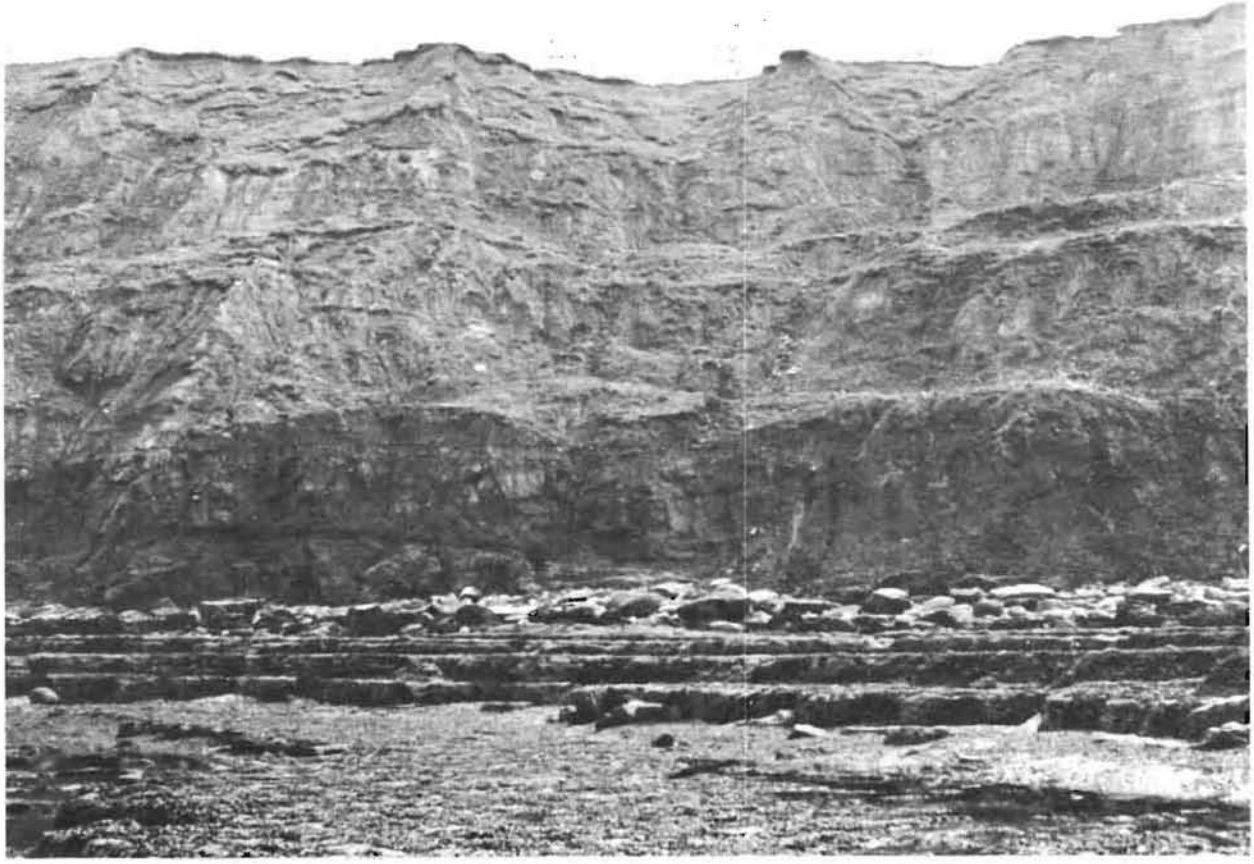


Plate. 1. Section at South Bay, Scarborough looking southwest, showing beds of the Scarborough formation forming a strong feature on the foreshore. The cliffs beyond show sandy beds of the Scalby Formation, with the Moor Grit at the base, unconformably capped by deposits of boulder clay. R.J. KING

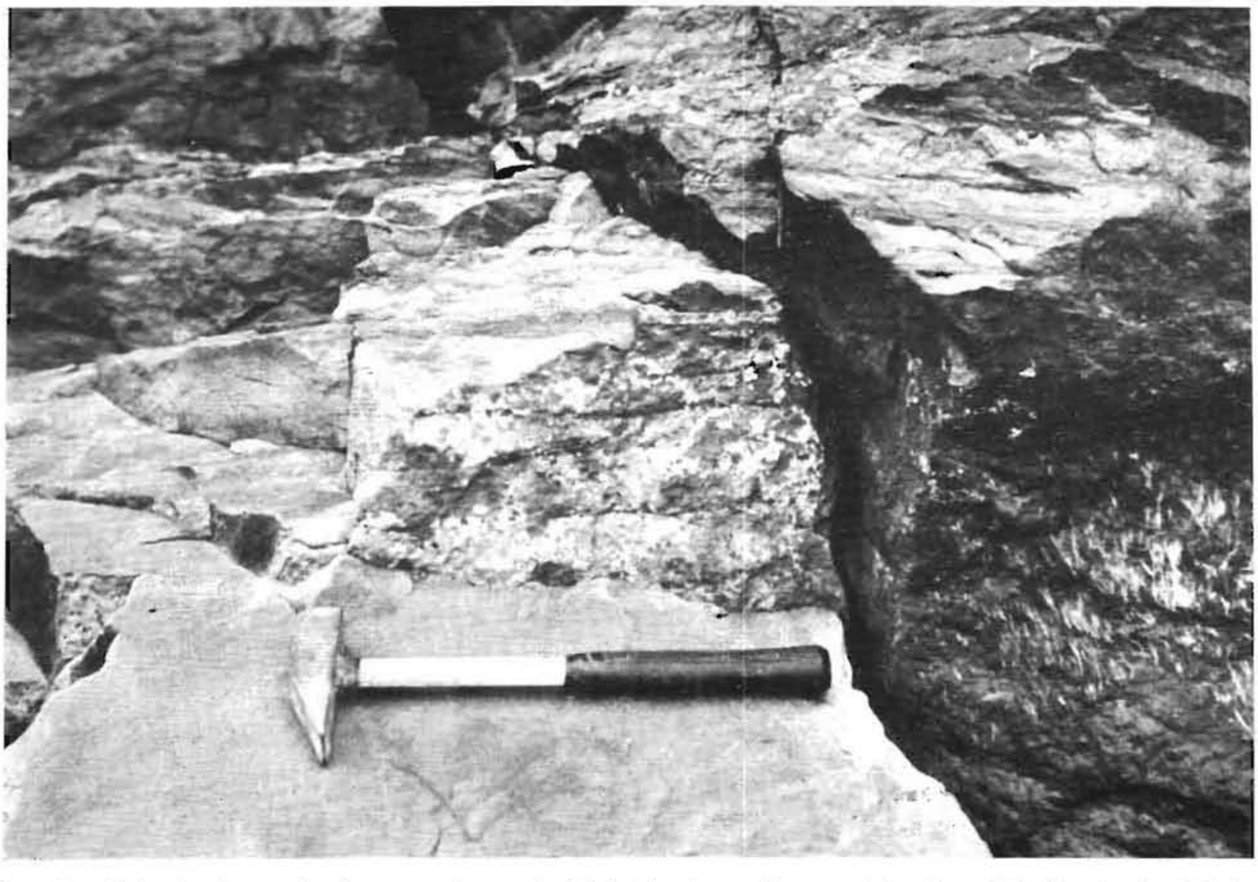


Plate 2. Veins bearing scarbroite occupying vertical joints in the sandstones of the Moor Grit (Basal unit of Scalby Formation). R.J. KING

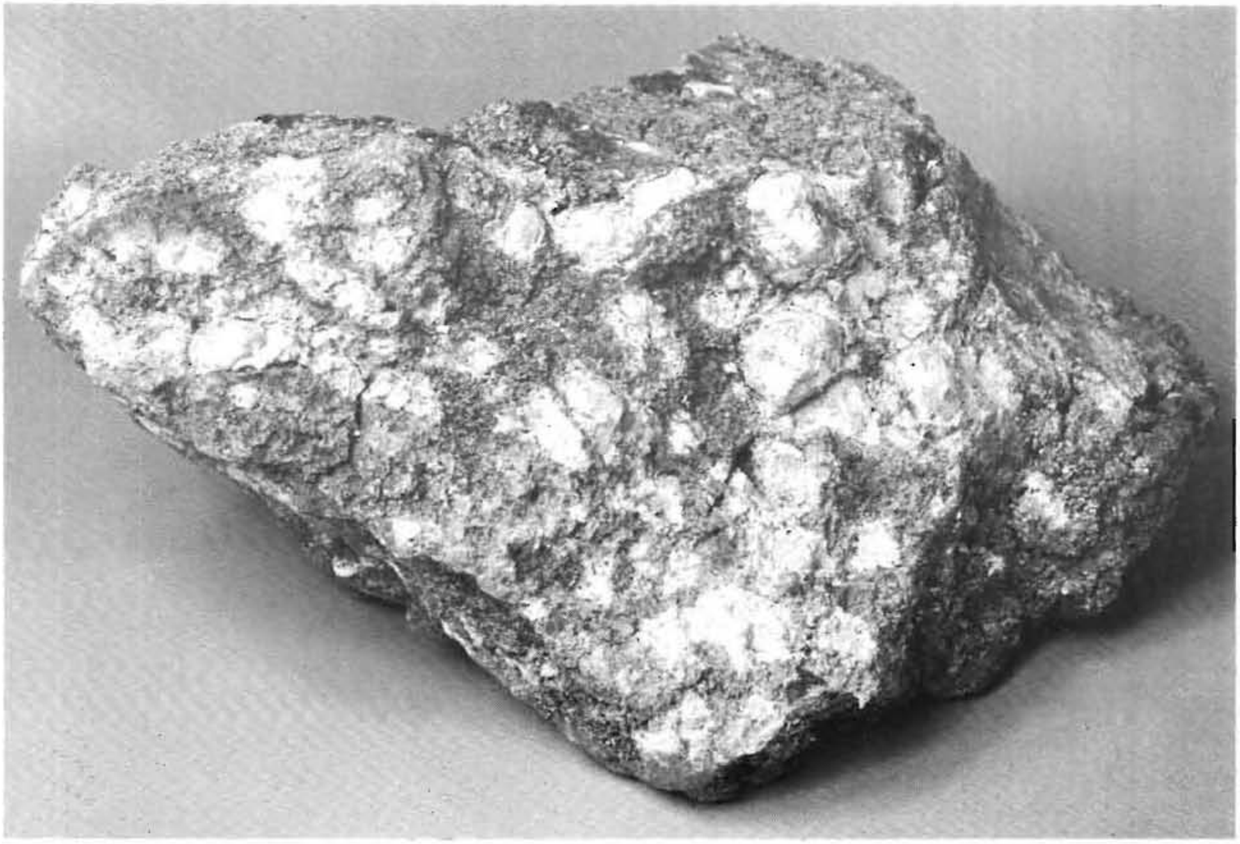
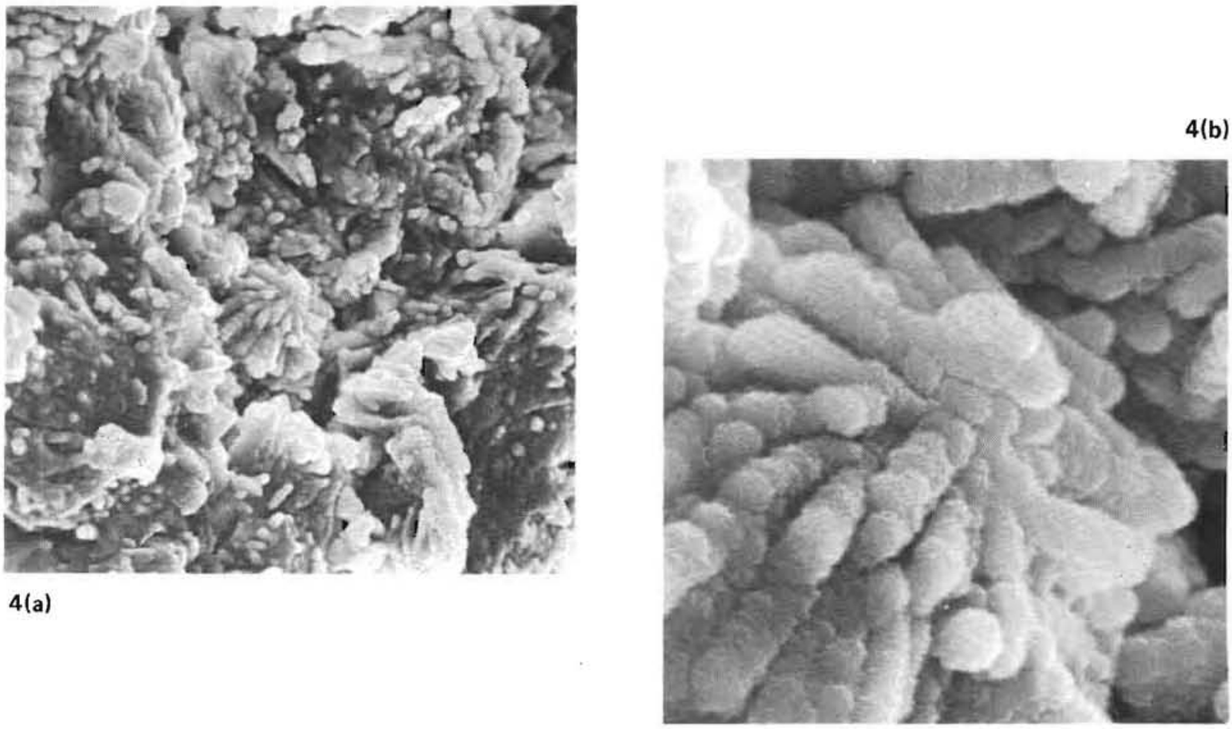


Plate 3. Portion of the sandy ferruginous contents of the "gull", showing nodular masses of pale orange coloured (5A3) scarbroite surrounded by pellicles of hydroscarbroite. Weston Favell, Northamptonshire. King collection, Accn. No. K8183-72. The specimen is 240mm long.



4(b)

4(a)

Plate 4. Scanning electron microscope (ISI60) micrographs of scarbroite from Weston Favell showing: 4(a) the overall surface features (X1100); and 4(b), an enlargement of the central area of plate 4(a), showing the stacking of crystal plates (X5500). Portion of K8183-72.

Eventually an analysis was carried out which produced the following data (Table 1). For purposes of comparison the analysis given by Duffin and Goodyear (1960, p.354) and Melmore (1930, p.10) are added.

TABLE 1

	Weston Favell[2]	Scarborough[3] (Melmore 1930)	Scarborough (Duffin and Goodyear, 1960)
SiO_2	9.24%	6.01%	3.20%
Al_2O_3	44.00	44.17	45.70
MgO	1.06		0.10
Na_2O	.61		1.70
K_2O	0.26		0.20
CO_2	5.17		7.90
H_2O	38.61	49.80	37.90
Cl	0.10		
SO_3	0.82		1.80
	99.87%	99.98%	98.50%

From their work based on the above analysis Duffin and Goodyear (1960, p.354) suggested that the material from the type locality at Scarborough was a basic aluminium carbonate with the idealized formula: $Al_2(CO_3)_3\ 12Al(OH)_3$. The presence of silica they attributed to free quartz and other minor contaminating constituents. Such contamination in the Scarborough material is understandable when one looks at the physical appearance of the material and its mode of occurrence where there is abundant risk of contamination in the conduit-like veins from wall rocks and debris from above.

The presence of 9.24% silica in the Weston Favell material is not so easily understandable. The analysis of K8183 was made from the interior of a hard compact nodule, presumably shielded from contamination post deposition of the scarbroite.

From their x-ray investigation, Duffin and Goodyear (1960), further suggested the presence of a triclinic cell and a layer structure analogous with that of gibbsite. Unlike the Scarborough material, that from Weston Favell is not readily dispersed in water and it was found difficult to produce weak enough dispersions suitable for study by electron microscope. As a result of this, and with the limitations imposed by the equipment available, it proved impossible to produce dispersions of single crystals upon which to conduct work to support that done by Brindley and Comer (1960, p. 363). Sufficient evidence was produced however, to show the general crystalline nature of the Weston Favell material and the two electron microscope micrographs (Plate 4(a) and (b)), were produced. Plate 4(b) is an enlargement of the central area of plate 4(a), and clearly shows the uneven stacking of crystal plates.

Footnote 2: Analysis accn. No. K8183 by G.W. Saville

3: Average of three.

Brindley and Comer's work (1960) proved the pseudo-hexagonal character of the material, but still left unanswered the true symmetry of the type material, whether it obeyed orthorhombic or monoclinic laws.

Subsequently Brindley (1980, p. 615), with the composition of Scarbroite written in the form $Al_5(OH)_{13}\ CO_3.5H_2O$, pointed out the close relationship to gibbsite ($Al(OH)_3$), as originally pointed out by Duffin and Goodyear (1960), and to hydrotalcite $Mg_6Al_2(OH)_{16}CO_3.4H_2O$.

vi. The mineralogy of the Scarborough occurrence

Much physico-chemical data on the Scarborough occurrence appears in the preceding section, but it may be of value to up-date Vernon's original physical description (1829, p.178)

Scarbroite from the type locality is white with an earthy lustre. When dry and compact, though soft (H.1), it has a sub-conchoidal fracture, but, unlike the Weston Favell material, may be broken between the fingers.

The scarbroite-bearing veins vary greatly in width, with a maximum observed cross section of 25mm. They are commonly lined on both sides by thin selvages of fine-grained highly ferruginous sandstone. The maximum observed thickness of scarbroite lying between the selvages was 17mm.

The Yorkshire Museum has in its geological collections a specimen labelled "Scarbroite. $Al_2O_3,x.H_2O$. Near Scarborough". It is composed of white chalk-like masses up to 17mm across, which may represent the now disintegrated portion of a vein. Though the specimen bears no accession number and cannot therefore be dated, it may well be the original material presented by Vernon to the Yorkshire Philosophical Society in 1826.

vii. Thoughts on the genesis of scarbroite

In common with most other mineral bodies, no hypothesis can be erected which categorically states that any stipulated mechanism can account for the genesis of the body.

The same might be said about both the Scarborough and Weston Favell occurrences. Both are fraught with chemical and physico-chemical unknowns which must remain as such until a detailed research project be mounted.

Very little has been published on the genesis of scarbroite at the type locality of Scarborough. The only hypothesis put forward was by Fox-Strangways (1892 p. 475), who tentatively suggested that organic remains may have played a part.

The most important clues to the origin of both deposits may lie in the similarities of form of mineral body and geology. In both occurrences the mineral itself is enclosed within selvages of ferruginous silt grade sandstones, although there the similarities end. At Weston Favell the scarbroite takes the form of discrete nodular masses within a sandy fill, which itself is enclosed by ferruginous sandy linings. At Scarborough, although the linings of the mineral body are similar to those at Weston Favell, the scarbroite takes the form of intermittent linear areas of deposition within the bounding ferruginous liners. It would seem likely that the two occurrences represent degrees of development, the Weston Favell occurrence being the strongest and most mature. It is also likely that the host lithologies have a bearing on the chemical content of the mineral bodies, where, for example, the dominance of carbonate at Weston Favell may be of importance.

The ubiquitous presence of iron oxides at both localities, in the mineral bodies themselves, as well as the host lithologies, may also be of considerable significance. Some of the iron may originally have been in the form of pyrite. Bardossy and White (1979, p. 355) have shown that the production of sulphuric acid resulting from the oxidation of pyrite in bauxite deposits can complete the oxidation processes of the pyrite and any other iron minerals present, and in some places aluminium-rich minerals as well. Such downward percolating solutions are neutralized several metres below the level of oxidation, thus allowing $Al(OH)_3$ gels to precipitate.

Previous to the publication of these observations, Sierra et al (1978, p. 324) had observed that the difference between the carbonate - containing Al $(OH)_3$ gel and scarbroite was particle size along with slight differences in ordering. They had also noted that scarbroite had been found associated with gibbsite ($Al(OH)_3$), the final crystalline form in the ageing of $Al(OH)_3$ gel.

Another important similarity between the two occurrences is in the presence of Pleistocene deposits overlying the Jurassic host lithologies. At Weston Favell, the relationship between the overlying blue and green gley clays and the beds of the underlying Northampton Sand Formation is obvious. The surprisingly low figure of 18.94% Al_2O_3[4] found by analysis of the blue clay may also be significant, and have bearing on the work done by Bardossy and White (1979, p. 355).

The formation of the scarbroite-filled "gulls" must therefore be due to the movement of water immediately previous to the deposition of the Chalky Boulder Clay at the onset of the Saale glaciation, i.e. at the time of the formation of the Mid-glacial gravels of Northamptonshire (Rice, 1968, p. 335) and be possibly connected with periglacial processes. Bannister and Hollingworth (1948), significantly ascribed the formation of "gulls" in the Northampton Sand Ironstone, and their accompanying aluminium-rich minerals, to weathering processes allied to periglacial phenomena. The feature is a common one throughout the iron ore field where such observations have been made easy by the abundance of vigorously working sections through the Northampton Sand Ironstone.

A similar geological situation occurs at Scarborough where many metres of Pleistocene boulder-clays overly the Jurassic sections. In South Bay at Scarborough scarbroite-bearing joints were seen to be truncated below the overlying boulder-clays. Their funnel-shaped throats were choked by debris from above and they bore evidence of downward circulating water. It seems likely therefore that this phenomenon may also be ascribed to periglacial activity immediately preceding the later Devensian glaciation (Penny, 1974, p. 257).

From the geological evidence it would seem likely that the genesis of aluminium-rich minerals, such as basaluminite, hydro-basaluminite, scarbroite and possibly others, is related to periglacial phenomena and have taken place in Pleistocene time.

It is tempting to apply Bardossy and White's hypothesis (1979) in the provision of a mechanism of deposition of Al $(OH)_3$ gels by oxidation-reduction processes in the weathering profiles of Pleistocene time.

At this point it is obvious that no firm conclusions on the genesis of scarbroite can be drawn, but it is hoped that the above observations may be of value to future research.

viii Acknowledgements

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The writer is grateful to Mrs. A. Spicer for her encouragement and for her skilful interpretation of my manuscript.

Footnote 4: Analysis by G.W. Saville.

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A NEW FIND OF NICKELOAN HYDROZINCITE IN THE PARC MINE, NORTH WALES.

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Recently, the discovery of nickeloan hydrozincite, $(Zn,Ni)_5(CO_3)_2(OH)_6$ was reported (Alwan and Williams, 1979) from the Parc mine, Gwynnedd, North Wales (National Grid reference SH788602). The mineral was found as a coating on the floor of a small crosscut in the No. 2 level, some 620 metres from the adit entrance. Only one specimen was collected at the time. Two small fragments were donated to the Musée de Mineralogie, Paris, and the National Museum of Wales, Cardiff. The remaining type material was deposited in the British Museum (Natural History), London. Some eighteen months after collection, the material was recognised as a new variety and a return trip to the mine was arranged. Unfortunately, at the type locality in the crosscut, more unsubstituted hydrozincite and ferric oxyhydroxides in abundance had obliterated any of the nickel-bearing species that had been present. A thorough search of the accessible workings in the No. 2 level failed to reveal any more material. However, in 1981, a visit to the more recently worked No. 3 level resulted in the discovery of a new site bearing nickeloan hydrozincite which we describe here.

The Parc mine is located in the Llanrwst mining district, near Betws-y-coed, Gwynnedd, and was formerly worked for lead and zinc (Dewey and Smith, 1922; Archer, 1959). It was the last mine in the field to cease working with its last recorded output in 1969. The ore occurs in steeply dipping veins along faults in the Crafnant volcanic series (Davies, 1936). Three sets of veins are easily distinguished, trending N-S, ENE-WSW and WNW-ESE. The veins dip on either side of the strike and the dip angle is generally high, varying from 65-90°. Almost all of the workings follow the veins as is shown in the plan of the two levels (Fig). The location of the type specimen of nickeloan hydrozincite in the crosscut on level 2 is marked on the figure, at the intersection of two of the veins. Overhead stoping on the N-S vein has been carried out in a southerly direction from the intersection, but this section of the workings was not explored owing to its being in an extremely dangerous state of collapse.

As is obvious from the plan, the new find of nickeloan hydrozincite in the No. 3 level is located at the intersection of the same two mineralized veins. No stoping was carried out in the N-S vein between the two levels. In the crosscut on level 3, the nickeloan hydrozincite was found as ice-green and apple-green coatings on the walls, and small stalactites in the back. Not all of the hydrozincite present was nickeloan, and only a few metres from the crosscut no nickel-substituted material was in evidence.

Because the mapping programme had revealed the extent of the distribution of the mineral to be limited to the one shoot, it seemed to be of interest to attempt to locate the primary source of the nickel. Accordingly, samples were taken of the primary mineralization in the back of the crosscut on level 3 and polished sections suitable for optical examination and electron microprobe analyses were prepared. In all sections the only sulphide minerals found were sphalerite, ZnS, galena, PbS and marcasite, FeS_2. The gangue was composed of angular fragments of black slate cemented by the above sulphides, together with quartz, calcite and ankerite. No nickel above the limit of detection (200 ppm) was found in any of the above minerals. The source of the nickel in the oxidized mineral thus remains unknown and no reason is evident for its confinement to the particular N-S ore shoot. In this connection it is worthwhile noting that other studies on the primary mineralization in the Parc mine (Archer, 1959; Jenkins, 1977) failed to disclosed any discrete nickel sulphide although primary pyrrhotine, $Fe_{1-x}S$, was reported to occur in the tuffaceous mudstones intersected by the principal ENE-WSW lode. We have also analysed specimens of this mineral by microprobe methods, but again its nickel content was below the limit of detection. The type specimen of nickeloan hydrozincite contained 3.76 and 4.12% Ni in two analyses (Alwan and Williams, **Op. Cit.**), giving rise to the chemical formula $Zn_{4.62,4.65}\ Ni_{0.38,0.35}\ (CO_3)_2(OH)_6$. Analysis of material using AAS methods from the new find did not extend the range of sibstitution. In some eleven specimens of green hydrozincite examined, the nickel content ranged from 0.53 to 2.46%. X-ray powder photographic examination of the minerals confirmed that no other nickel carbonates were present as was the case with the type material. However in two of the specimens lines corresponding to aragonite were observed. The presence of aragonite was unrelated to nickel content.

The range of substitution of Ni(II) for Zn(II) in hydrozincite of natural origin is thus limited so far to a maximum Ni/Zn ratio of about 0.08. This value is certainly not the upper limit as laboratory studies have shown that some 19% by weight of nickel may take the place of zinc in the hydrozincite lattice without the formation of other Ni-bearing minerals (Abdul-Samad **et al.**, 1981), following the synthetic procedure of Neczaj-Hruzewicz **et al.**, (1977). Analyses of other specimens may therefore reveal material which contains a good deal more nickel, and indeed other transition and related metals, than has been found so far.

The Parc mine, and others in the Llanrwst mining field, is now administered by the Forestry Commission to whom all correspondence for permission to enter should be addressed. The authors however stress that they do not encourage collectors to visit the site due to the extemely hazardous conditions now prevailing in the workings.

Acknowledgements. We wish to thank the Forestry Commission for permission to carry out our studies at the Parc mine. Thanks are also due to Sheila Bevins, Adrienne Williams and Tim O'Brien for assistance during the mapping and surveying of levels 2 and 3.

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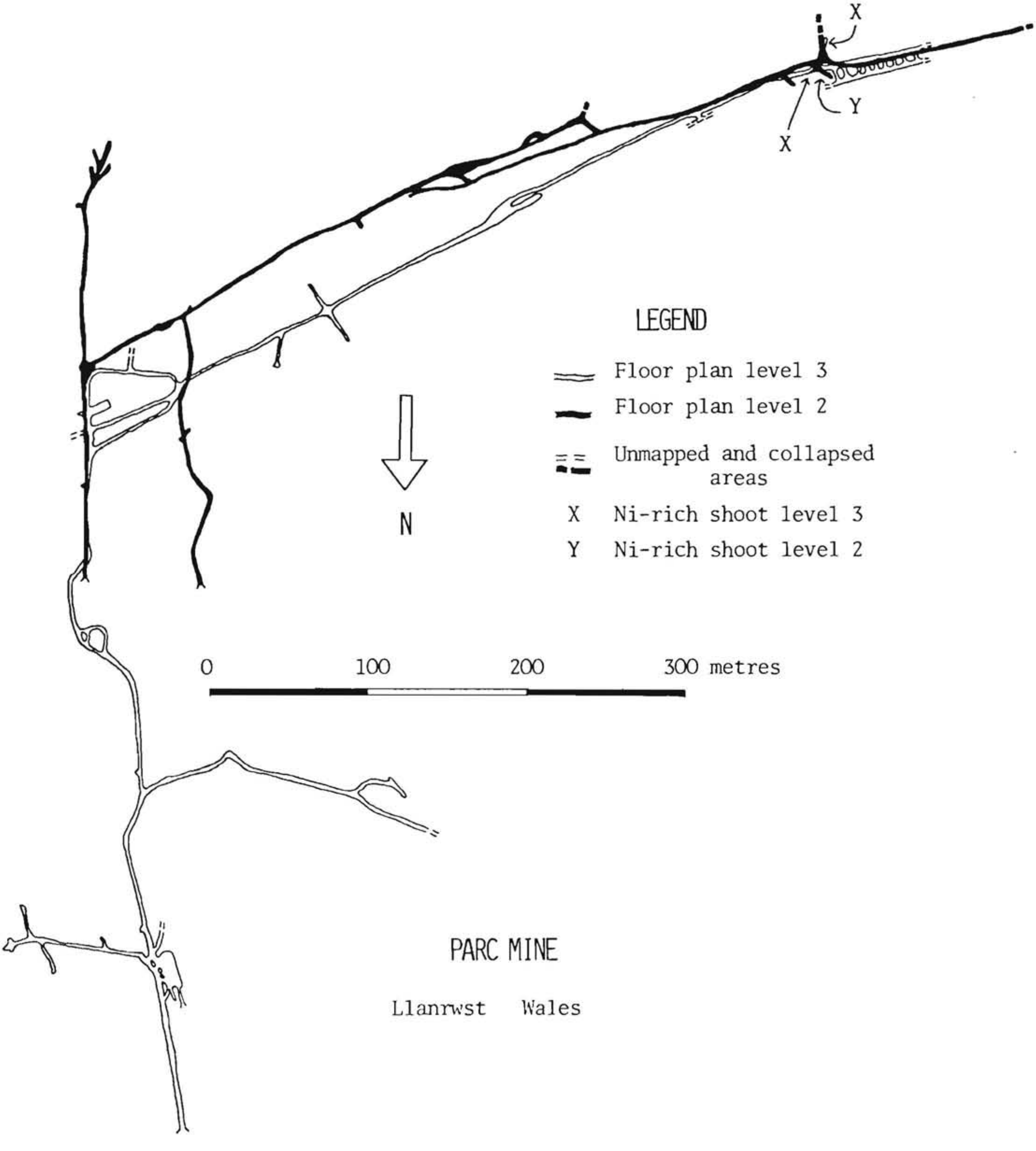
FIGURE I

Plan of levels 2 and 3



The content of rare earth elements in English fluorites: a preliminary study.

by

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Abstract. Determinations of the rare earth elements (REE) in English fluorites show not only that do the fluorescent Weardale fluorites contain ten times more REE than the non-fluorescent Derbyshire fluorites but that the distribution pattern of the individual REE is different, the Weardale fluorites showing a strong positive Eu anomaly.

Early work on fluorite, and particlarly that attempting to relate the colour of the mineral to its chemistry, noted the tendency for some varieties to contain appreciable rare earths. The fluorescence of some fluorites, a phenomenon itself named for its characteristic occurrence in this mineral, has also been linked with the presence of rare earths (Yoshimura, 1934; Przibram, 1938). British fluorites were studied by Dunham (1952) who found that, in general, strong fluorescence is associated with relatively high contents of Eu, La, and Ce.

Until recently the accurate determination of the individual rare earths has been difficult, often necessitating time-consuming chemical separations or neutron-activation analysis. The advent of the inductively coupled plasma spectrometer (ICPS), however, in combination with a simple ion-exchange method for separating the rare earths (Walsh & Howie, 1980; Walsh **et al.**, 1981) has made available a powerful and rapid method of analysis. Some preliminary results in eleven British fluorites are reported here.

The contents of 11 rare-earths (and also yttrium) in the fluorites selected for study are reported in Table 1.

Table 1

Rare earth elements in fluorite (in p.p.m.)

	1	2	3	4	5	6	7	8	9	10	11
La	1.8	2.0	4.5	1.0	3.0	8.6	5.4	4.9	14.3	20.8	176
Ce	2.0	2.6	3.1	1.4	2.3	3.7	11.8	10.8	29.2	43.0	435
Nd	0.9	2.1	2.1	1.5	0.9	1.1	9.9	11.9	27.7	40.3	340
Sm	0.48	0.88	0.83	0.68	1.3	0.47	4.2	8.0	14.1	18.7	72.3
Eu	0.15	0.11	0.20	0.19	0.67	0.22	1.17	20.9	46.3	46.7	1.09
Gd	0.46	0.84	0.90	1.04	3.4	0.83	7.0	18.5	27.2	38.9	54.9
Dy	0.55	1.05	0.64	0.97	2.22	4.1	7.5	17.3	22.1	33.2	34.6
Ho	0.28	0.38	0.51	0.34	0.89	0.78	1.32	2.9	3.5	5.1	6.8
Er	0.49	0.85	1.20	0.55	1.29	1.39	3.0	5.6	7.0	11.1	20.3
Yb	0.21	0.49	0.17	0.19	0.32	0.41	1.85	2.45	2.71	4.2	13.1
Lu	0.05	0.09	0.16	0.05	0.14	0.24	0.23	0.29	0.31	0.47	1.7
Y	10.9	20.7	12.0	18.4	38.3	5.3	105.2	186.8	198.5	350	538
ΣREE	7	11	14	8	16	22	53	103	194	260	1152

Key

1. Colourless fluorite, Ladywash mine, Eyam, Derbyshire
2. Purple portion of Blue John, Treak Cliff, Castleton, Derbyshire
3. White portion of Blue John, Treak Cliff, Castleton, Derbyshire
4. Colourless fluorite, Pateley Bridge, Yorkshire
5. Light blue fluorite, Florence mine, Egremont, Cumbria
6. Dark blue fluorite, joint face in aplite, Meldon, Okehampton, Devonshire
7. Yellow fluorite, Wheal Trehane, Cornwall
8. Deep green fluorite, Heights mine, Weardale
9. Bleached fluorite, Weardale
10. Deep purple fluorite, Haggs mine, Nenthead, Cumbria
11. Green transparent fluorite, Cornwall

The Derbyshire samples, both the white and the purple zones of Blue John from Treak Cliff as well as the colourless fluorite from Ladywash mine, Eyam, are particularly low in total rare earths, as are the colourless fluorite from Pateley Bridge, Yorkshire, and the light blue fluorite with associated dolomite and hematite from Florence mine, Egremont, Cumbria. It is noteworthy that the Derbyshire fluorites show no appreciable fluorescence. The blue fluorite from joint faces on the Meldon aplite, Okehampton, Devonshire, is also low in rare earths, but yellow fluorite from Wheal Trehane, Cornwall, is slightly richer.

The Weardale fluorites, long known for their intense fluorescence, are shown to be particularly rich in rare earths. Thus the purple fluorite from Nenthead as well as the delicately coloured green fluorite from Heights mine are both rich in the lighter REE and are particularly enriched in europium. Although artificial crystals of fluorite grown from melts containing various quantities of samarium fluoride were green, leading to the suggestion (Feofilov, 1956) that the green colouration of some natural fluorites might be due to the presence of Sm^{2+}, the green fluorite from Heights mine is unremarkable in its Sm content. The more vivid green specimen from Cornwall does however contain more than 70 p.p.m. of Sm.

It is customary for geochemists to express REE analyses not only in absolute terms (parts per million) but relative to their known abundance in chondritic meteorites (as a yardstick of comparative enrichment or depletion). The chondrite normalised abundances for these fluorites, using the chondrite values recommended by Nakamura (1974), are plotted in Figs. 1 and 2. In Fig. 1, it can be seen that quite apart from the Weardale fluorites being some ten times richer in rare earth elements than the Derbyshire samples, the distribution of the individual REE are clearly very different. The Derbyshire and Yorkshire fluorites show a slight negative europium anomaly whereas the Weardale fluorites all show a strong positive Eu anomaly, with Eu being up to 600 times more abundant than for an average chondrite.

Rare earths determined in fluorites by neutron activation analysis have been investigated by Marchand **et al.** (1976) and Grappin **et al.** (1979). These authors give numerous plots of REE against normalised chondritic abundance values for French fluorites, mostly showing small positive Eu anomolies but not as large as those for Weardale fluorites. Marchand **et al.** also discriminate between green and white fluorites by their Sm/Ce ratios, but the values for our samples plot outside either field. In a series of papers Schneider and Möller and their co-workers have attempted to link the genesis of fluorites to their REE contents (Schneider **et al.**, 1975; Möller **et al.**, 1976; Gundlach **et al.**, 1976; Schneider **et al.**, 1977; Bellanca **et al.**, 1981). By plotting Tb/Ca against Tb/La Schneider **et al.** were able to differentiate pegmatitic (pneumatolytic), hydrothermal, and sedimentary fluorites from various Alpine paragenses. Although the present data do not include values for Tb, estimates can be made by averaging the values for Gd and Dy on either side, but when this is done most of our samples other than those from the southern Pennines are too rich in 'Tb' to plot on the Schneider diagrams.

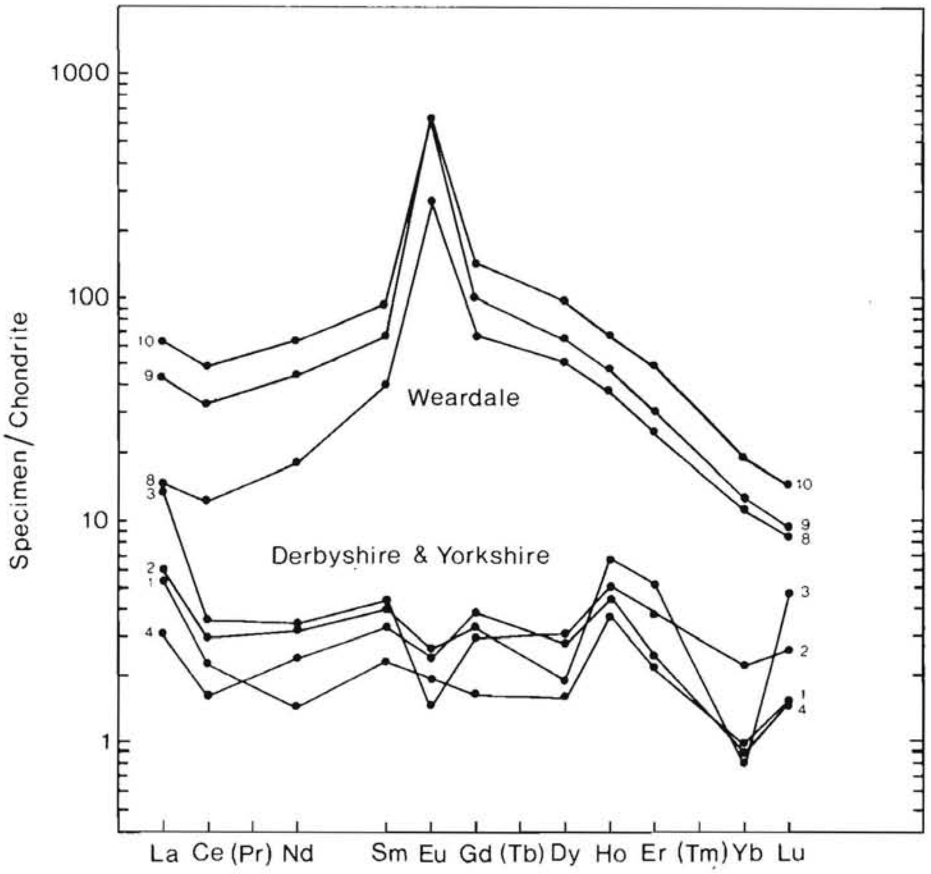

Fig. 1. Chondrite-normalised plots of REE in Pennine fluorites

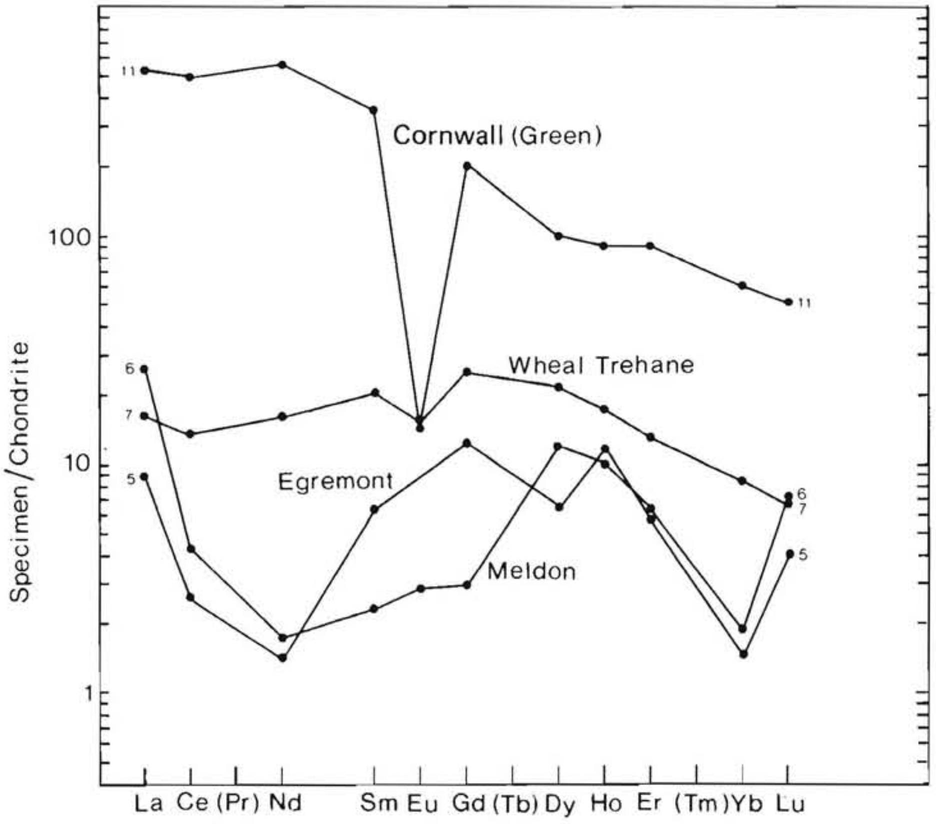

Fig. 2. Chondrite normalised plots of REE in fluorites from Cumbria and SW England.

In this initial reconnaissance of English fluorites, four other specimens were examined (Fig. 2). The light blue fluorite from the Florence mine, Egremont, Cumbria, is associated with hematite and dolomite, and although its content of REE is at the same level as for those from Derbyshire, the distribution pattern is somewhat different. The Meldon fluorite of completely different paragenesis associated with a granitic aplite also has a fairly low REE content. The two Cornish specimens however are somewhat richer in rare earths, the green massive fluorite of specimen 11 being remarkably rich, with a total of 1152 p.p.m. together with 538 p.p.m. of yttrium; both specimens have a negative Eu anomaly.

Clearly before these preliminary results can have significance many more samples from a wider range of localities and parageneses need to be studied. It will also be necessary to study the distribution of the REE between the fluorite and the other vein minerals and also the country rock.

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THE MINERALOGY OF FALL HILL QUARRY, ASHOVER, DERBYSHIRE

M.E. SMITH

Fall Hill Quarry is located on the north side of the Ashover to Milltown road, the B6036, southwest of Ashover village (Nat. Grid Ref. SK 33 3555624). The quårry is at the time of writing (1981) being backfilled but when working, exclusively for Fluorspar, was exceptionally deep in relation to its linear dimensions.

The quarry's geological location is at the southwest end of the Ashover anticline, a structure which exposes the limestone for about one mile along its length and about half a mile wide at its midpoint. The anticline appears to have a core of volcanic rock, the origin of which is in itself the subject of some discussion. It is variously referred to as a toadstone, which usually means any volcanic or volcanically derived rock, possibly an ash or tuff. The other suggestion is that it may well be intrusive or a volcanic vent with assocaited lavas. The volcanic rock which, for descriptive purposes, is here referred to as toadstone, contains sub-angular fragments of fine silicified limestone up to about 15" diameter.

The specific geology of the quarry is complex. Looking down into the quarry from the west end, the toadstone which forms the left flank of the pit appears to be a fault plane. The limestone above shows pronounced slickensiding and this toadstone itself is traversed longitudinally by a minor fault with a calcite infill. The toadstone is of a coarse-grained nature, drab green in colour containing small but visible grains of pyrite. It has been classified as an olivine basalt in a borehole near Ashover.

It is along this structural disturbance that mineralization took place. The Ashover Old Vein, sometimes referred to as Fall Hill Vein, occupies this tectonic disturbance. The workings on it were to be seen in the quarry as well as at Butts Quarry situated a little further towards Ashover. Where this vein is exposed in the quarry it is about 8 feet wide. The cheek of the vein forms the right hand flank of the quarry, giving rise to some localised contact metasomatism of the wall rocks evident at lower levels. The vein was previously worked from a mine at the west end of the quarry, the site of which is occupied by a small fluorite plant. This vein was drained at depth by a branch of Cockwell Sough.

The physical geology is better shown by the accompanying photographs.

Some of the more important minerals and their occurrence are now discussed:—

1. Marcasite FeS_2

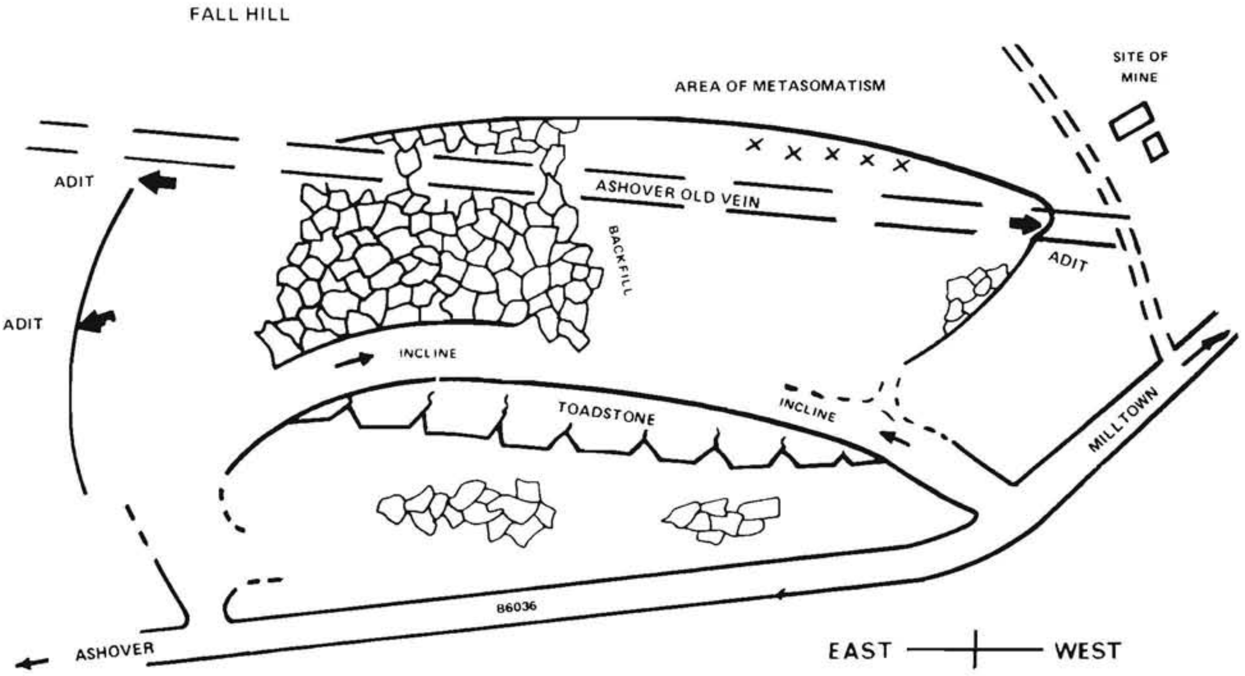
The most interesting mineral to be found was marcasite. Although not uncommon in the area, it is unusual to find it occurring as bright unaltered crystals. The size varies from 1-12mm. in length. The terminations of the crystal are very deeply serrated. The marcasite appears to originate on the periphery of fluorite crystals adjacent to a line of marcasite inclusions and at right angles to the cube face of the fluorite. Occasionally twinning rosettes occur on the corner of cubes. The occurrence of these bright crystals appear to be localised in only two vughs. Other marcasite within the immediate area is tarnished or coated with limonite. Much of the marcasite at other sites in the quarry has altered to goethite which has in turn broken down to limonite. Where this has occurred, deep corrosion pits are left in the fluorite, sometimes with goethite/limonite remnants in the bottom of the pit.

2. Sphalerite ZnS

Sphalerite is evident as crystals associated with fluorite and ranging from 1-6mm in length. They may occasionally be coated with greenockite and a small quantity of 'Rosen-Blend' has been noted.

3. Galena PbS

During the late 18th and 19th centuries the principal ore originally worked on the Old Ashover Vein was galena. and most vein sections contain the ore. It was known to be high in silver. Small cubo-octahedra are associated with the fluorite, some of which have been reduced to a skeletal state. Fresh galena is exceptionally bright, but crystals are frequently coated with cerussite. Galena present in the vein high in the west end is associated with a minor amount of cerussite and lime-green pyromorphite.



4. Pyrite FeS_2

Most of the pyrite was seen in the toadstone as microscopical sized cubic crystals. Where the toadstone has weathered, the pyrite has been altered to limonite. Small crystals of pyrite are also evident on the surfaces of quartz crystals.

5. Goethite $FeO(OH)$

Minute spherical masses of goethite are seen on the faces of some quartz crystals.

6. Millerite NiS

Millerite has been found embedded in calcite within the toadstone usually associated with chalcopyrite. The mineral takes the form of bright 'brassy' metallic filaments.

7. Baryte $BaSO_4$

Baryte occurs as white cockscomb rosettes, some with small crystals of pyrite growing within the comb. It is usually associated with the fluorite, and occurs in a massive form within the vein structure at the top of the quarry.

8. Smithsonite $ZnCO_3$

Smithsonite is present as small elliptical, semi-spherical or botryoidal crystals on fluorite. The colour is variable, from pale amber to dark brown, when it may be visually mistaken for hydrocarbon.

9. Greenockite and Hawleyite CdS

Greenockite was noted at the location in 1972, but as the quarry deepened it became more abundant. It is deposited as a canary yellow powdery’ coating, mainly on the fluorite. No discernable crystals have been found. When the mineral is found on sphalerite it has an iridescent appearance. Electron microprobe and X-ray diffraction powder data show that some material previously thought to be greenockite is the cubic dimorph HAWLEYITE, this material appears to be slightly yellower than greenockite and is the first recorded occurrence of this mineral in the United Kingdom.

10. Fluorite CaF_2

Fluorite occurs extensively through the quarry as good cubic crystals and also as granular deposits following breakdown within the vein. On the higher levels in the old part of the quarry crystals attain faces to 75mm square, but are grey in colour and rarely transparent. Many of the vughs in the face of the quarry contain crystallized fluorite but the crystal faces have the usual ubiquitous coating of limonite, although fluorite at the present working depth appears to be free from this association. Much of the fluorite at this point has inclusions of marcasite which are zoned within the growth lattice of the crystal. Some secondary fluorite was noted on marcasite as a stoss-side deposit.

11. Calcite $CaCO_3$

Crystals up to 30mm. long are associated with the fluorite where they occur loosely adhering to the underside of the fluorite masses. Veins of calcite, fibrous in habit, occur in the toadstone associated with small pyrite crystals.

12. Hydrocarbons

The precise species of hydrocarbon has not been identified. It occurs as brown/black spherules on fluorite up to 6mm diameter. Where the hydrocarbon has become hardened it displays a good conchoidal fracture, but most spherules are semi-plastic. Occasionally only a 'shell' remains containing a viscous tar-like substance. In one instance the marcasite was seen to enclose an hydrocarbon spherule.

13. Quartz SiO_2

Well formed euhedral quartz occurs in small vughs within the limestone. It is also a constituent of the vein mineralization. Small pyrite crystals are dispersed on crystal faces.

Vein Section

The vein section is very complex, the minerals are irregular in deposition across its width. The presence of quartz in the vein is, for Derbyshire, also unusual.

The sequence across the vein is as follows:—

Fluorite

Calcite — with sphalerite and minor smithsonite

Calcite — with galena

Quartz

Galena

Calcite

Fluorite

14. Other Minerals

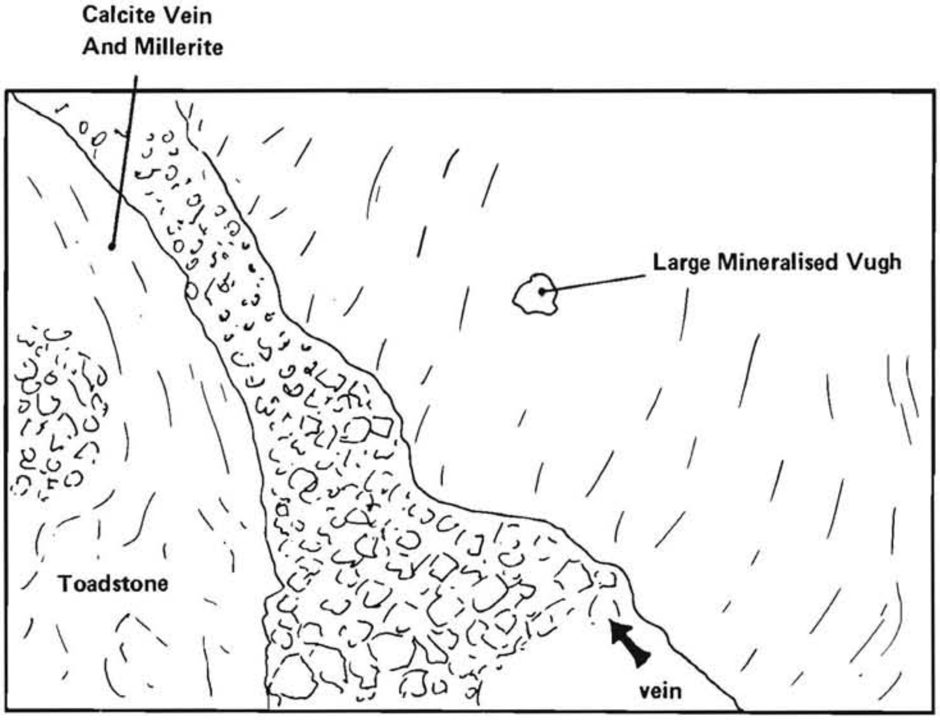
Not discussed are the composite minerals within the toadstone, chlorite, olivine, delessite, etc. Also noted is the minor occurrence of chalcopyrite attended by the usual green oxidation staining.

Appended is a list of minerals found within the Ashover area. It is not complete, but serves as a guide to the minerals which may be encountered.

The Tansley Boreholes

A borehole was put down at Tansley for geological exploration during 1955 at SK 33 045958. This site is about 2 miles west of Fall Hill. At a depth of 985 feet 6 inches an oblique vein in limestone was intersected. The minerals identifed in this vein were pyrite, millerite, pyrrhotine, chalcopyrite and

FALL HILL



Looking East from
right of vein

Plate 1

FALL HILL

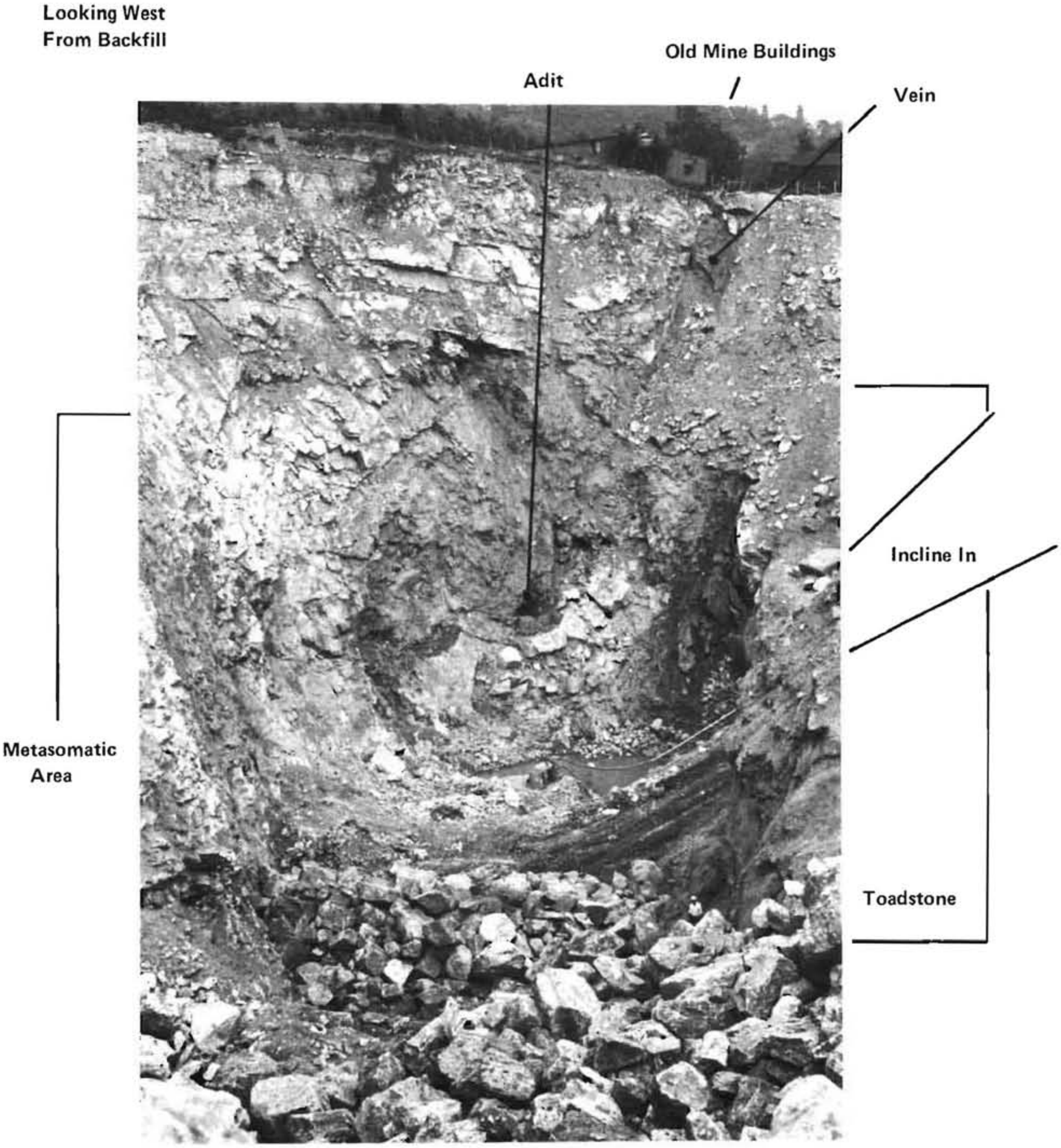


Plate 2

sphalerite. Also recorded is a small veinlet of bravoite associated with pyrite, marcasite and calcite at a depth of 1025 feet. This borehole terminated in olivine basalt at a depth of 1142 feet. It will be noted that these minerals, particularly the millerite, occur in limestone not the toadstone as does the millerite in Fall Hill quarry.

The second borehole at Upperton commenced in shale and terminated in limestone, intersecting a small calcite vein only. The last 60 feet was in limestone.

The third borehole sunk at Highoredish on the opposite side of the valley to Fall Hill recorded calcite, sphalerite and it was noted that much oil was in evidence.

The fourth borehole, at Fall Hill, apparently in the west end of the quarry, recorded only oil, calcite and fluorite in seven small veins but appears to have missed the toadstone. It terminated in barren limestone at 220 feet.

MINERALS RECORDED FROM ASHOVER

Anglesite	Fall Hill (unconfirmed)
Aragonite	Ashover (6)
Baryte	General
Bravoite	Tansley Borehole
Calcite	General
Cerussite	Fall Hill, Butts Quarry, Gregory Mine
Collophane	Tansley Borehole (1)
Chalcopyrite	Fall Hill, Tansley Borehole
Fluorite	General
Galena	General
Goethite	Fall Hill
Hawleyite	Fall Hill
Haematite	Ashover Toadstone (5) and (7)
Hydrocarbons (var. unspecified)	Fall Hill
Limonite	General
Magnetite	Ashover Toadstone (5) and (6)
Malachite	Gregory Mine
Marcasite	Fall Hill, Tansley Borehole
Millerite	Fall Hill, Tansley Borehole
Pyromorphite	Fall Hill
Pyrrhotine	Tansley Borehole
Pyrite	General
Quartz	General
Smithsonite	Fall Hill, Butts Quarry
Sphalerite	General
Stibnite	Gregory Mine (3) (Unconfirmed)
Wurtzite	Gregory Mine

My thanks to N. Moreton for providing the photographs and technical assistance. Also to P. Braithwaite for helpful discussion and providing scale and 'human interest' in the photographs. Thanks are also due to the British Museum (Natural History) for the identification of Hawleyite.

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An Occurrence of Nickel Minerals in the Hilton Mine, Scordale, Cumbria

T.F. Bridges

Summary

A deposit of a few kilograms of nickel minerals in the Hilton Mine, Scordale is described. The nickel minerals are, in order of abundance, niccolite, gersdorffite and millerite with the secondary oxidation product annabergite. Descriptions of these and other associated minerals are given together with a paragenetic sequence for the deposit.

Introduction

Nickel minerals have been noted from a few localities in the Pennines. Ullmannite, nickel antimony sulphide, was first found by Spencer (1910) at New Brancepeth Colliery in a vein of baryte and witherite. The arsenide, niccolite, was found by Russell (1927) in the Settlingstones Mine, where it occurred with sphalerite, galena and ullmannite in a vein of witherite. More recently Ixer (1978) described bravoite from Millclose Mine in Derbyshire and gersdorffite and glaucodot from various northern Pennine localities (1979).

Described here is a deposit of several kilograms of nickel minerals, dominated by niccolite but also containing gersdoffite and traces of millerite. Secondary alteration has oxidised part of the niccolite to annabergite. These minerals occurred associated with fluorite, galena, etc. in a single deposit in the Hilton Mine, Scordale.

Geology

Scordale is a deeply incised valley running NE into the western flanks of Mickle Fell (2591 ft.). The prominence to the east of the valley is called Hilton Fell and that to the west, Murton Fell. The whole area is one of open moorland. The mines (OS. NY.763226) are situated about 2 miles upstream of Hilton village.

The underlying rocks of the region consist of a series of beds of hard grey limestone separated by softer beds of mixed shales, sandstones and limestones. In Scordale the beds date to the Lower Carboniferous and in fact the Carboniferous Basement is exposed in the vicinity.

The Whin Sill occurs at a wide variety of different horizons in the Orefield. In Scordale, it is intruded just above the Melmerby Scar Limestone (D_1 age) and attains a thickness here of about 9m. It forms a prominent steep buttress in the upper parts of the valley.

Mineralisation has developed in a series of E/W trending veins. In Hilton Mine the minerals are largely restricted to the Melmerby Scar Limestone and in particular the beds above the Whin Sill are virtually barren. Large flats have developed on the veins just below the Whin Sill and these have been worked in a series of passages and chambers.

It is not the purpose here to describe the general mineralogy in detail. Briefly, baryte is abundant as large white bladed masses in the walls and fluorite is also common as a limestone replacement, frequently in small yellow to colourless cubic crystals. Occasional silicified masses of wall rock and skeletal masses showing euhedral quartz development are frequent. Small euhedral crystals of galena are abundant in the fluorite and quite large pods and lenses of massive galena occur in places.

A good summary of the geology and mineralogy of the area is to be found in Sir Kingsley Dunham's memoir on the Northern Pennine Orefield (1948).

History

Hilton Mine and the neighbouring mines across the Hilton Beck, Murton Mines, were worked by the London Lead Co. from 1824 to 1876. During this period, the combined output from both mines amounted to approximately 10,000t. of lead concentrates.

In 1896 the mines were re-opened to produce baryte and operated until 1919 under a variety of companies. It is interesting to note that some witherite was also won.

There was a final brief phase of operation in the 1930s.

In more recent years, the Hilton Mine has been of particular interest to mineralogists for the fine specimens of amber coloured fluorite that it has produced. Notable specimens of baryte have also been found.

For some years an area of green staining was observed on the walls of the Dow Scar High Level, but dismissed as copper stains. However, J. R. Trantom probed this area and produced several coppery red coloured specimens of niccolite with associated annabergite. The gersdorffite and millerite were found later by microscopic examination of the material.

Situation and Dimensions

The deposit was situated on the eastern wall of the Dow Scar High Level, about 100m. from the entrance. At this point a small buttress of rock had been left on the wall increasing in size close to the roof similar to the capital on a column. The nickel deposit was on the "capital" at its junction with the wall and hard up against the roof. Fig. 1

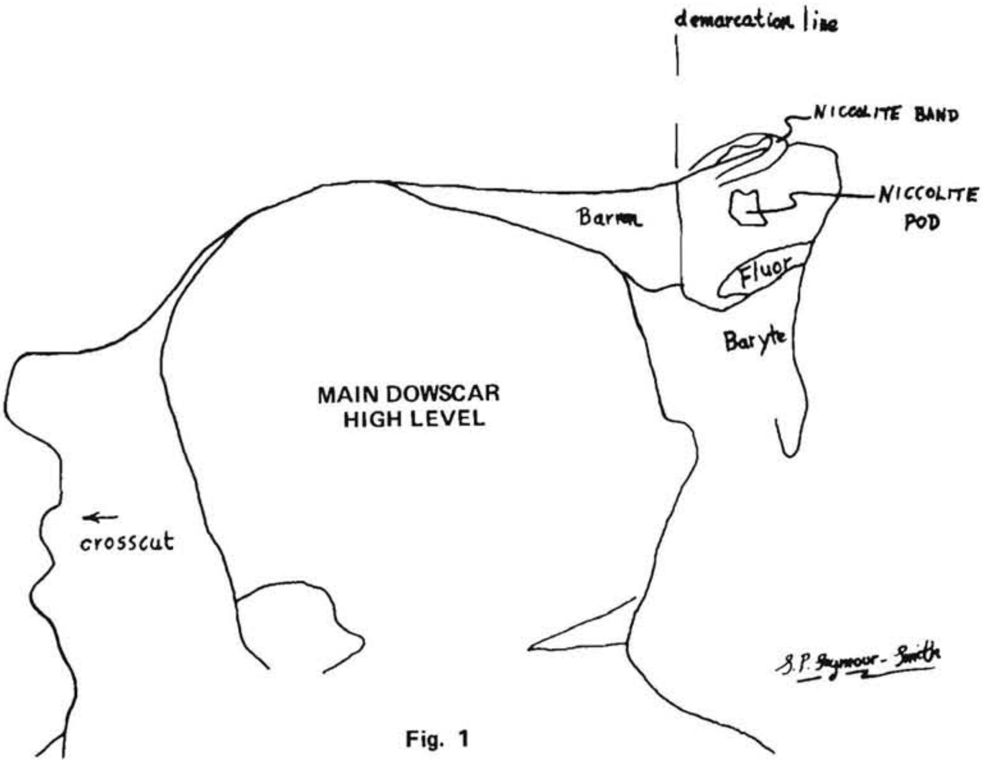


Fig. 1

The dimensions of the exposed nickel mineralised area were 13cms. width by 12cms. height. Refer to Fig 2 & 3.

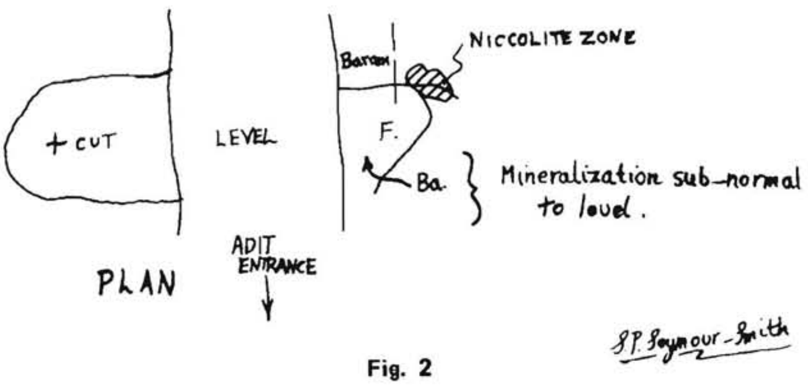


Fig. 2

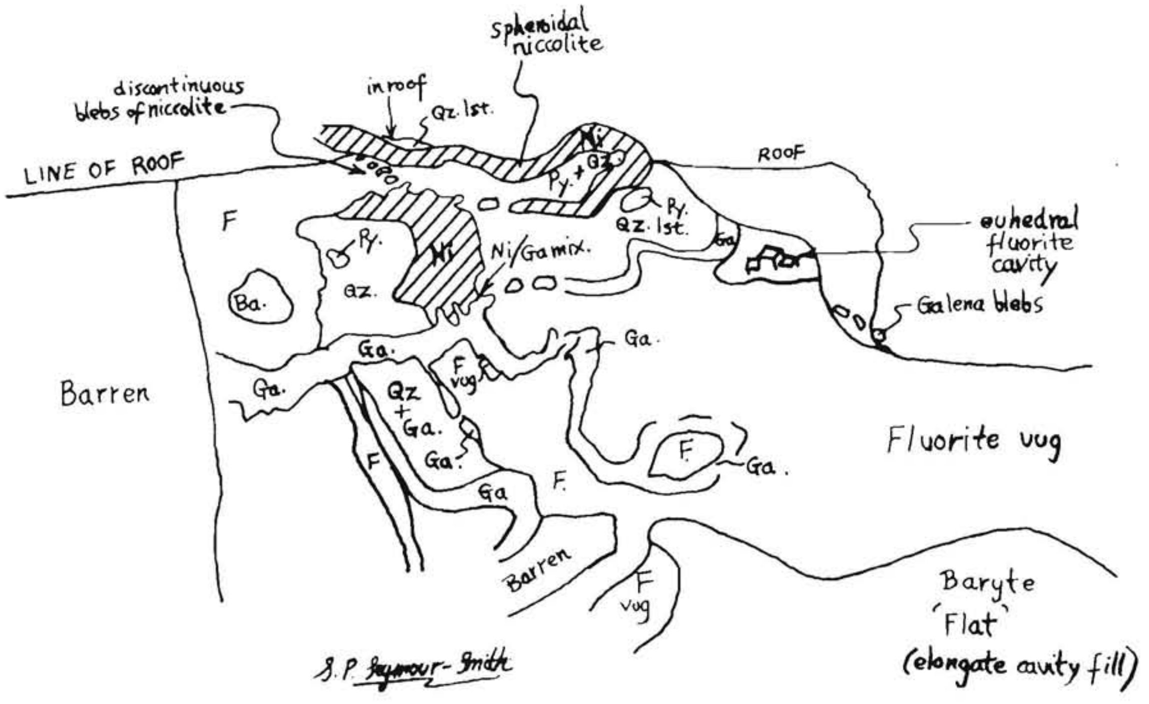
In order to investigate the deposit further, it was necessary to remove the protecting rock "capital". The overall depth of the deposit was then found to be 28cms., with height increasing to 25cms.

The overall maximum dimensions were therefore 13cms. width, 25cms. height and 28cms. depth. The depth dimension is orientated along the vein (and level). However, the original driving of the level removed an indeterminate part of the deposit.

The roof of the mine in this area is extremely flat and was thought to be the base of the Whin Sill. However, a flake of rock removed from the roof is very fine grained and white to pale brown in colour, and is considered to be a well baked shale.

The wall rocks in the area around the deposit were silicified and extremely hard and tough. However some of the rock fragments were largely soluble in dilute hydrochloric acid, indicating a high residual calcium carbonate level. The deposit itself occupied a brecciated area and had infilled the cavities around the breccia fragments.

Schematic diagram of niccolite mineralization in easterly wall of Dow Scar High Level, Hilton Mine, Scordale.



S.P. Seymour-Smith

Fig. 3

Key

Ni	Niccolite
Ga	Galena
Py	Pyrite
Qz	Quartz(massive)
Qz	1st Silicified limestone
Ba	Baryte
F	Fluorite

1. Top Niccolite pod — upper part (in roof) ¾" thick (20mm)
   — lower part $3^1/_8$" thick (80mm)
2. Bottom Niccolite pod — 3½" x 2" deep (88mm x 50mm)

Bearing for Dow Scar High Level is approx. 055°.

Occurrence of niccolite is 350 feet in from adit portal.

(i) Niccolite. NiAs

The most abundant nickel mineral present. On fresh fractures, it is a coppery red colour frequently showing a radiating structure. It is, however, much oxidised and is clearly the main source of the annabergite. On oxidised surfaces it is black.

The bulk of the niccolite occurred in small veinlets and part spheres to 2 cms. radius, but some has an arborescent structure with branches 1 to 2 cms. long and up to 3-4 mms. diameter. The largest pieces of niccolite were on and in the roof rock.

The niccolite is usually coated with gersdorffite and also occurs intergrown with gersdorffite and galena.

The identity of the mineral has been confirmed by X-ray diffraction. Qualitative chemical analysis shows a minor amount of sulphur and antimony to be present in addition to nickel and arsenic. Simple hardness testing has consistently given too low a hardness, but this may be associated with the structure of the mineral.

(ii) Gersdorffite. NiAsS

This mineral occurs as a brilliant silvery micro crystalline (1 mm.) crust over much of the niccolite. It also occurs as thin bands in niccolite. The crystals are complex octahedral modifications of the cube and closely resemble crystals from the Harz Mountains.

The identification has been confirmed by X-ray diffraction. Qualitative chemical analysis shows the presence of nickel, arsenic and a distinct amount of sulphur. No antimony was found but the available sample was very small.

(iii) Millerite. NiS

Micro needles of this mineral to 2 mm. in length have been found in gersdorffite coated cavities in the niccolite. Fresh needles are golden in colour, but many have been blackened. Crystals of galena and quartz are often present and the cavities are often partly filled with annabergite.

(iv) Annabergite. $Ni_3 (AsO_4)_2 8H_2O$

Massive, non crystalline annabergite has been deposited in many of the cavities in the deposit. The colour varies from green to brown. In a few cavities, micro (1 mm.) clear green monoclinic crystals (selenite type) have grown.

The identification has been confirmed by X-ray diffraction. Qualititive chemical analysis of the brown material shows the presence of iron and antimony in addition to nickel and aresenic.

(v) Galena. PbS

Galena occurs intergrown with niccolite and as euhedral cubo-octahedral crystals on the gersdorffite. It also occurs as sub to anhedral masses (to 1 cm.) in the fluorite matrix in the deposit and as euhedral crystals in some of the fluorite cavities.

(vi) Pyrite. FeS_2

Some of the fragments of brecciated rock contain anhedral to euhedral spots of pyrite.

(vii) Sphalerite. ZnS

Two pieces of rock from the deposit contain a thin veinlet of brown mineral of typical sphalerite appearance. Some of the breccia fragments contain small spots which are also probably sphalerite.

(viii) Fluorite. CaF_2

The main constituent of the infill around the breccia fragments and nickel minerals. Colourless to pale yellow crystals to 1 cm. on edge were found in the remaining open cavities in and around the deposit.

(ix) Quartz. SiO_2

A major constituent of the rock around and in the deposit. Good, colourless, euhedral micro crystals (often double terminated with short prism section) occurred in the fluorite matrix of the deposit, usually on gersdorffite, but occasionally on galena and fluorite. Quartz does not appear intergrown with niccolite or gersdorffite.

(x) Cerussite. $PbCO_3$

Some of the galena in the deposit is partly coated with micro crystals with the appearance of cerussite and which effervesce with dilute nitric acid. These are attributed to cerussite.

(xi) Anglesite. $PbSO_4$ (probable)

One cavity in galena which contains some crystals of cerussite, contains micro crystals with the appearance of anglesite and which do not effervesce with dilute nitric acid. These probably are anglesite, but there is too little for a positive identification.

(xii) Aragonite/Calcite. $CaCO_3$

One cavitylinedwith fluorite crystals contained a tiny group of white radiating needle clusters which are probably aragonite but may be calcite. There is too little for a positive identification without completely destroying the specimen.

(xiii) Erythrite. $CO_3 (AsO_4)_2\ 8H_2\ O$ (probable)

The writer's attention was drawn to pink stains on some of the brecciated rock fragments by Dr. R.J. King. Qualititive chemical analysis confirms the presence of cobalt. Primary cobalt has not been found. Wet chemistry has failed to detect cobalt in the niccolite, but this does not exclude the possibility of its presence at a very low level.

Paragenesis.

There were many cavities in and around the deposit varying from about 1mm. in size to about 10 cms. The larger cavities were mostly around the periphery of the nickel area and were lined with fluorite and occasional crystals of galena. Many of the cavities were infilled wholly or partially with annabergite.

The smallest cavities were usually in niccolite and lined with gersdorffite together with some crystals of galena, fluorite and quartz. Millerite when present bridged gersdorffite and sometimes quartz and galena. Again many of these cavities were infilled with annabergite.

Unfortunately, the material from the deposit crumbled badly during extraction. In this situation the radiating structure of much of the niccolite has been invaluable in determining the paragenesis.

(i) The earliest phase of mineralisation seems to have been partial wall rock replacement by pyrite, silica, minor galena and possibly sphalerite. Breccia fragments have the appearance of partial recrystalisation with calcite grains reaching ½ mm. in size. The silica rim round many of the rock fragments are often iron stained and in some places quartz crystals have developed.

(ii) This was followed by the niccolite phase. Minor galena is incorporated in the niccolite, probably through most of the sequence, but certainly near the beginning and end.

(iii) Near the end of the niccolite phase, gersdorffite appeared and some intergrowth with niccolite occurred. Much but not all of the niccolite was finally encrusted with gersdorffite.

(iv) Galena then coated a lot of the gersdorffite and uncoated niccolite with good euhedral cubo-octahedral crystals.

(v) Minor fluorite is probably the next mineral to occur, followed rapidly by quartz. These two minerals seem to have sealed off most of the small gersdorffite cavities.

(vi) Millerite does not appear to penetrate the quartz crystals and therefore probably occurred after the quartz phase.

(vii) Then followed the main deposition of fluorite and galena which brought to a close the primary sequence.

(viii) The aragonite/calcite is probably the next mineral to occur since some of it is stained with annabergite.

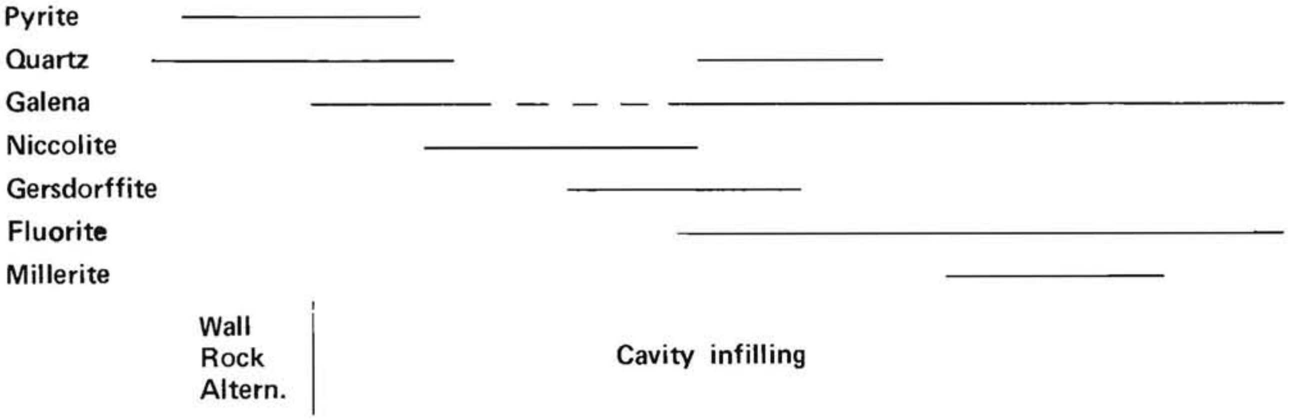
(ix) At a later stage, possibly only since the mine was opened, oxidation of the deposit gave rise to the formation of annabergite from the niccolite, cerussite, probably anglesite and the iron and manganese stains which affect some of the material.

The above leaves two minerals which cannot be definitely placed in the sequence. The probable erythrite, perhaps better referred to as a secondary cobalt mineral, almost certainly belongs to the final oxidation stage. However, without a positive identification of the mineral or source of primary cobalt, there is some doubt about its position in the sequence.

Sphalerite on first appearances seemed to belong to the earliest wall rock alteration stage. However, one speciment inspected (collection of J. Jones) seems to show some intergrowth with niccolite and gersdorffite. This may indicate sphalerite to belong to a later stage in the sequence.

Fig. 4 represents the primary paragenetic sequence omitting sphalerite.

Fig. 4 — Paragenesis of Primary Mineralisation



Discussion

The source of the nickel minerals can only be speculated upon. Nickel minerals are frequently associated with basic rocks. In the Hilton Mine and Settlingstones Mine deposits, the nickel minerals are closely associated with the Whin Sill and it is at least possible that the nickel has been derived from the Sill by some extraction process. However, if this is the case, it is perhaps remarkable that so little nickel has been found in the rest of the N. Pennine Orefield considering the widespread presence of the Sill. Certainly diligent searching in the Hilton Mine failed to reveal any trace of similar mineralisation elsewhere.

It is interesting to note that the gersdorffite is unaffected by the oxidation, unlike material from the Harz Mountains which is unstable in air.

Specimen Material

Specimens from the deposit are available to researchers for inspection in the writer's collection, the collection of J.R. Trantom, the collection of J.A. Jones and other members of the Russell Society. One typical specimen has been placed in the Mineral Collections, University Museum, Oxford.

Access

The following notes have been recently obtained from the Northern Mines Research Society who have been co-operating with the army to keep Hilton Mine open for research:—

HILTON AND MURTON MINES, SCORDALE, CUMBRIA.

The Scordale mines are situated on army training ranges and as such can only be visited when firing is not taking place on the range.

The only underground workings which at present are accessible are those at the Hilton Mines. Access to these mines is by Dow Scar or Middle Level entrances and both these entrances have steel gates and are locked.

The army will only allow underground visits to the mine if work to be carried out is of a scientific nature and under no circumstances are mineral specimens to be taken from the mine.

Anyone wishing to visit the Mine should contact Mr. D.M. Goth, who liaises with the army on access and available dates, at the address given below.

Surface remains at all the Scordale Mines can be visited at any time when firing is not taking place on the ranges. (Check with the training camp at Warcop.)

NOTE. – Since the Mines are on land used as a military firing range, DO NOT touch any object which looks in the least bit suspicious since it may explode and kill you.

For access to Hilton Mine Contact:–

Mr. D.M. Goth,
"Schonerwald",
Deer Park Lane,
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FIRST BRITISH OCCURRENCE OF CUMENGÉITE

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Abstract

Cumengéite has been found in Cornwall, associated with other secondary lead and copper minerals, within a primary lead copper antimony sulphide vein. The chemical environment in which the primary mineralization occurs could allow for the prediction that cumengéite might be found.

Introduction

Cumengéite was located at Newporth beach, in the parish of Budock, approximately two kilometres to the south west of Falmouth, Cornwall; national grid reference: 204 799/303. This occurrence is the first so far discovered in the British Isles and is the third known locality for the mineral in the world. Specimens have been obtained from Santa Rosalia, Baja California, Mexico (Wilson and Rocha, 1955), and from slag at Laurium in Greece (Yedlin, 1973).

Geology

The rock forming the cliffline at Newporth beach consists of Middle Devonian shales, siltstones and minor sandstones, comprising part of the 'Mylor Beds' (Edmonds et al, 1975). They underwent low temperature regional metamorphism, to form phyllites, during the latter part of the Middle Devonian Period. The phyllites show extensive small scale folding, with well developed false cleavage oblique to the bedding, the cleavage dipping about 60 degrees to the south east and the beds about 50° to the south east (Hill et al, 1906). Minor faulting is in evidence.

Into this strata was intruded a late stage siliceous hydrothermal phase of mineralization, bearing metallic elements; probably during the Upper Carboniferous Period when the Carnmenellis Granite was intruded (Edmonds et al, 1975). This hydrothermal phase indurated the phyllites, forming veins, made prominent by quartz lenses.

A Pleistocene raised beach deposit rests unconformably upon the phyllites. It comprises fine to coarse – grained sub rounded rock fragments, including mineral – bearing quartz vein material notably containing bournonite and bindheimite. The deposit, which may be auriferous (Hill et al, 1906), is cemented by wad.

HISTORY OF MINING AND SPECIMEN ACQUISITION

The parish of Budock has seen a little metal mining in bygone centuries, mainly for lead, as at Wheal Penrose, though evidence for such activities has been largely obliterated by changes in land usage. Wheal Penrose, presumably inland from the coast but not far from Newporth beach, is said to have produced lead, zinc and copper ores, though there are no records of the yields (Dines, 1956). Wheal Pennance, a trial which consisted of three shafts (Stephens, 1886, 193), to the north east of Pennance Mill, was following a lode, an extention of that worked for lead and silver at Swanpool Mine, one kilometre to the south west of Falmouth and within that parish. Copper ores were mined at Wheal Anna Maria, three kilometres east south east of Constantine, an adjacent parish; antimony ores and bournonite were reported from the dumps (Cunnack, 1908).

Some minor workings can still be seen along the coastline; shallow trial adits where mineral veins have been excavated back into the cliff face.

It was after a search for bournonite in 1980 that cumengéite was found and recognised in one of the mineral veins on Newporth beach. Subsequently cumengéite was recognised in crystals up to 4mm across, associated with bournonite, lining a vugh in vein quartz and in bournonite-bearing pebbles from the raised beach, previously collected in 1972. My search for these veins was further prompted by the knowledge that lead and antimony ores were once mined in the area.

Minerals Discovered

Primary sulphides identified within this vein include: bournonite $PbCuSbS_3$, tetrahedrite $(Cu,Fe)_{12}Sb_4S_{13}$, galena PbS, with minor amounts of chalcopyrite $CuFeS_2$, pyrrhotine $Fe_{1-x}S$ and pyrite FeS_2. Of these, tetrahedrite and galena are invariably in crystal form, tetrahedrite crystals being up to 2mm. in size and exhibiting a metallic lustre; there is no secondary coating of chalcopyrite, which is abnormal for Cornish tetrahedrite. Bournonite rarely exhibits good crystal form, it occurs mainly massive, however, its very presence here is of interest considering the limited number of sites in the British Isles at which this mineral can be readily obtained.

Secondary minerals occur here; bindheimite $Pb_{2-y}SB_{2-x}(O,OH,H_2O)_{6-7}$ with decreasing quantities of: cerussite $PbCO_3$, goethite FeO.OH, cumengéite $Pb_{19}Cu_{24}Cl_{42}(OH)_{44}$, atacamite $Cu_2Cl(OH)_3$., malachite $Cu_2(CO_3)(OH)_2$ and anglesite $PbSO_4$. The identity of bindheimite, cumengéite and atacamite was revealed by X-ray powder diffraction and scanning microprobe analyses.

Bindheimite ranges in colour from sulphur yellow to yellow orange. It is often resinous and poorly microcrystalline, frequently forming thick crusts around a core of massive bournonite, which suggests alteration from that sulphide. Cerussite is abundant, frequently forming twinned crystals up to 8mm. in length, often lining quartz vughs. Cumengéite occurs as pale blue microcrystalline crusts. It is late in the paragensis and coats the bournonite, the rock matrix, quartz and cerussite. It is intimately associated with bindheimite and atacamite and appears to coalesce into an amorphous mass. One crystal of anglesite was formed.

Chemical Environment

Chemical conditions for the formation of cumengeite are ideal at this sea cliff locality, a factor not attained at the other sites of occurrence of the mineral. Cumengéite will only form where the chloride ion concentration is high and will remain stable only at this high level (Humphreys et al, 1980) and where the pH is alkaline (Fawzy et al, 1981). Sea water provides both these stability requirements for cumengéite. Weathering of the primary sulphides by sea water and atmospheric exposure made available the elements lead and copper, which by combination with aqueous chloride ions allowed for the formation of cumengéite.

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Section One THE CLEANING OF MINERALS

The term 'cleaning', as used by certain publications, especially in the United States of America, can imply the modification of a mineralogical assemblage or association by the use of strong chemicals. When considering the cleanliness or the cleaning of minerals, the collector should therefore come to terms with the ethics of his actions in the application of two quite distinct concepts, one: to remove matter foreign to a mineral paragenesis, or, two: to remove associated minerals from a paragenesis leaving one of its members free. The former usually implies the removal of such matter as dust, clays or hydrocarbon compounds, and is cleaning in the strict sense of the word. The latter implies the removal of associated minerals, including the products of oxidation, from the surfaces of the principal mineral of the paragenesis. Such a process demands the use of chemicals alien to the chemistry of the paragenesis, which may promote instability, and in no sense can the process be termed cleaning. To prevent confusion between the two concepts the terms cleaning **sensu stricto** for the former and development for the latter, will be used throughout the following text. The term development, perhaps best known as a palaeontological technique is used here to describe the release of a mineral from its associates.

It should also be borne in mind that many techniques used in the preparation of archaeological specimens are best described as development techniques and are quite unsuited for use on naturally occurring mineralogical material. Mineral specimens are almost always intimately associated aggregates of minerals. The use of any one development technique, while admirably developing the principal mineral of the aggregate, places the remainder at risk.

The collector now has to make a decision. Should he, for example, remove the coating of brochantite on a fine specimen of native copper, or should he simply wash the specimen in running water to remove any dust or loose matter and preserve the specimen in its natural state? If he adopts the first course, he faces the risk of causing irreversible damage, not only to the original paragenesis, but also to the species which remain. The native copper, once freed from its associate, is now in a state of metastability, due largely to the action of the chemicals used to effect the change. Admittedly the copper now exhibits the text book rose-red colour, but not for long. Copper tarnishes quickly, almost visibly, especially under strong lighting or following certain treatment in acids, and the collector must then resort to coating his specimen with some form of lacquer to inhibit the tarnish. This will certainly retain the possibly desired rose-red colour, but has destroyed the true lustre of the mineral and worsened the situation.

Even scientifically undiciplined washing can produce irreversible damage to mineral associations. It is unfortunate to hear of the case of the enthusiastic collector who vigorously scrubbed off the minute but unnoticed well-crystallized plates of wulfenite from the cerussite-coated surfaces of a specimen of galèna, or of the other who failed to notice the completely unattached capillary crystals of cosalite in vughs in the surfaces of clay-encrusted quartz crystals.

No longer can we afford to learn from our mistakes, the material is too valuable to put at risk. It is part of the natural heritage, and its source of supply is rapidly diminishing.

Whatever other motives a collector of minerals may have, his principal duty to his science should be to preserve the material in his care in its natural state and ensure its conservation for posterity as far as his resources will permit.

The cleaning of minerals is examined under four separate headings:

1. Original from the field cleaning.
2. Routine cleaning.
3. Cleaning following neglect.
4. Development and cleaning techniques.

In the final section a selection has been made of minerals most commonly subjected to development techniques. In certain cases the more responsible cleaning techniques follow the irresponsible development techniques.

In all four sections a knowledge of mineralogy is essential, especially concerning the basic stability factors of the material to be cleaned. Many valuable specimens have been destroyed through ignorance and it is always advisable, should there be any doubt to seek advice. Section (1) follows. Sections (2-4) will follow insubsequent numbers of the journal.

1. Original from the field cleaning.

When collected from the field every mineral should be accompanied by field data. From this the collector may establish the geological environment of his material. He must also be confident about the scope of his species identification, or at least be able to establish the essential chemistry of the material; whether it be a group of sulphates, sulphides, etc. If there is doubt in his mind on these points he should consult a specialist.

If the material before him is of his own collecting, or it has been donated by an experienced collector, then the collector from his knowledge of the field relationships, the geological environment, and his species identification, should select a cleaning technique best suited to the specimens. Above all he should bear in mind the golden rule with minerals: the less handled the better for them. Obviously no single cleaning technique is suitable to all minerals. Indeed the same technique may be completely unacceptable to the same species from a different locality for many and complex reasons.

Over ninety per cent of all material collected from the field will need nothing more than a gentle wash under a tap of lukewarm water, to remove any dust or mud which may have accumulated during its collection. An ideal unit which will meet most cleaning requirements may readily be made from thick-walled rubber gas tubing. Both hot and cold tapped water supplies are joined by a union joint to produce a constant supply of lukewarm water (about 30°C). This is allowed, either to run from an open tube on the union joint or is led to a fine jet by the insertion of a copper tube brought to a fine nozzle into the hose. The fine jet is ideal for the removal of clay or other particles deeply embedded in crystal interstices. If the material under examination is sufficiently stable, previously soaking it in water containing a little detergent will greatly assist any cleaning process.

During any washing process, loosely adhering associate minerals, such as hydrous iron oxides, manganese dioxides, etc., may also be removed, and the collector must decide whether he wishes this to happen. In the same way, before submitting his material to vigorous washing, he must check that there are no associated minerals on his apparently competent material which may in fact be of more interest than the identified material and would be lost during washing.

Removal of Clay

Many minerals collected from the field will be covered naturally with clay minerals in which they have grown. For example, in areas of metasomatized limestones, vughs and sometimes caverns, completely filled with clay, may contain single euhedral bi-pyramids or groups of crystals growing **in situ.** Carbonate minerals are common in this environment, calcite in particular. These, on extraction, will be completely covered with clay. This is best left on the crystals until they reach laboratory conditions. If lengthy storage time prior to washing, examination and possible accessioning, is expected, then the clay, though permitted to remain on the specimens, must be allowed to dry thoroughly, and the specimens should be replaced into numbered storage.

Should the specimens be carried from the field in polythene or other plastic bags, they must be removed from them as quickly as possible. Polythene bags are a mixed blessing. While valuable for the carriage of wet material, this should not be allowed to remain sealed in them for long periods.

For example if clay-covered calcites are allowed to remain wet in polythene bags for long periods of storage, overgrowths of new calcite may develop. This overgrowth, though in crystallographic continuity, presents a 'frosted' appearance to the originally high-lustred material.

The removal of clay from mineral specimens usually presents no problems, except in the case of groups of prismatic crystals, where, it may lodge between crystal interstices. If this is the case and where the mineral itself is stable and insoluble in water, soaking in water to which a little ammonia has been added will sufficiently deflocculate the clay to enable its removal under a jet of water. A little detergent added to the water instead of ammonia is also quite efficient. A thin splint of bamboo is used as a probe in conjunction with the water jet greatly increases the efficiency of the operation.

With water soluble and delicate minerals the problems are acute. Short term soaking in ethyl alcohol followed by the use of the jet on an alcohol-filled wash bottle is often effective, but the alcohol on the specimen must not be allowed to evaporate to dryness until the process of clay removal has been completed.

Removal of lichens, etc.

Some material collected out of the field will be more or less covered by lichens or algae. Though most less likely to be affected than rock specimens, lichens may grow on minerals found on out-cropping lodes, etc., and their removal is just as desirable.

These plants are usually quite easily removed owing to their preference to grow on hard and unfriable surfaces, though their life processes can cause mineral breakdown.

If the surface on which they are growing is hard, the lichens, etc. are allowed to dry out completely and then are vigorously brushed off by using a small nylon handbrush. If the material is not too robust, the application of a dilute solution of ammonia in water, while the specimen is damp from the field, will help to soften lichens and algae, which may then be removed by brushing under a flow of water.

The use of concentrated acids in the removal of lichens and algae from the surfaces of minerals is not recommended, though the careful and selective application of concentrated sulphuric and nitric acids may be used with good effect on some rock specimens.

Ultrasonic Cleaners

The use of ultrasonic devices for cleaning minerals has been recommended (Sinkankas, 1970,p.287) and the writer would agree up to a point. Their use is more common amongst palaeontologists, where they have their value in the development of fossils. Their use in mineralogy is limited, however, and may be disastrous as was pointed out by MacLeod (1970). It is an unpleasant experience to see a well-cleaved mineral disintegrate within seconds of immersion!

Should the collector have access to an instrument with a variable range between 20-40 kilocycles, then it may be advantageous to use it for the out-of-field cleaning of poorly-cleavable material, especially in the cleaning of epimorphic textures which have subsequently filled with clay. Solutions of detergent in water are recommended for use in the tanks of ultrasonic cleaners and, as stated above, weak solutions of ammonia in water greatly assist in the de-flocculation of clays.

The writer feels there is little merit in the acquisition of an expensive piece of electronic equipment to produce an effect equalled by the use of water and a brush, and would never use such an instrument in the cleaning of any mineral in his collection. Ultrasonic cleaners have such limited use in routine cleaning that they are not considered insubsequent sections of this chapter.

Cleaning Fragile Specimens

Crystal habit alone may decide the cleaning technique to be used. The great fragility of capillary and acicular habits, especially where basal cleavage planes are present, rules out many of the more physically vigorous techniques. Fortunately, the fact that the habits naturally exist suggests that the mineral was well protected from contamination or mechanical modification. An amygdale, full of crystallized zeolites cannot be matched for the beauty of crystal shape,purity of colour and cleanliness of its contents. Once it is in his hands, it is now the responsibility of the collector to ensure the continuation of those qualities of natural perfection. Too often they are lost through neglect or ignorance and the snow-like masses of crystals become dusty. Once that has happened the specimen is virtually ruined and only partially successful remedial measures may be taken, as explained below.

It is obvious that conventional cleaning methods cannot be employed on such fragile material. Water, whether static or flowing can cause great damage to capillary crystals through the effects of surface tension, and dry mechanical methods are better employed. The selective blowing of air onto specimens, using such an instrument as a hand blower used by photographic processors, is usually effective in the dislodging of any foreign matter trapped between the interstices of crystals. Micro-manipulative suction apparatus used, for example, in the radio industry and adapted by palaeontologists as a picking device for micro-fauna, is also useful for removing particles of foreign matter from delicate surfaces. A moistened wisp of cellulose tissue on the end of a bamboo splint will also pick up foreign matter quite efficiently. If the specimen has a robust base, such as basalt in the case of a zeolite-filled amygdale, foreign matter may often be dislodged by the simple expedient of careful inversion of the specimen, or by gently lowering the inverted specimen several times by hand into a solution of detergent in water.

Capillary crystals, especially matted aggregates adopting the plumose habit, such as boulangerite or jamesonite, may sometimes be washed by immersing the specimen in ethyl alcohol, or less effectively, ether. Great care should be taken for minerals adopting this habit are often completely unattached to the matrix and will literally float off the specimen. In water the same minerals will become matted and quite unrecognisable.

Table No. 1. A list of some minerals commonly found in capillary or acicular habits

Alunogen	$Al_2(SO_4)_3.18H_2O$
Aragonite	$CaCO_3$
Aurichalcite	$(Zn,Cu)_5 (CO_3)_2(OH)_6$
Bismuthinite	Bi_2S_3
Boothite	$CuSO_4.7H_2O$
Boulangerite	$Pb_5Sb_4S_{11}$
Brochantite	$CU_4SO_4(OH)_6$
Cerussite	$PbCO_3$
Chalcotrichite	Cu_2O
Chrysotile	$Mg_3Si_2O_5(OH)_4$
Cyanotrichite	$Cu_4Al_2SO_4(OH)_{12}.2H_2O$
Epsomite	$MgSO_4.7H_2O$
Erionite	$NaKCaAl_4Si_{12}O_{32}.12H_2O$
Goethite	$FeO.OH$
Gonnardite	$Na_2CaAl_4Si_6O_{20}.7H_2O$
Goslarite	$ZnSO_4.7H_2O$
Gypsum	$CaSO_4.2H_2O$
Halotrichite (of Glocker)	$Fe^2Al_2(SO_4)_4.22H_2O$
Hydrozincite	$Zn_5(CO_3)_2(OH)_6$
Jamesonite	$Pb_4FeSb_6S_{14}$
Kermesite	Sb_2S_2O
Malachite	$Cu_2CO_3(OH)_2$
Melanterite	$FeSO_4.7H_2O$
Meneghinite	$Pb_{13}Sb_7S_{23}$

Mesolite	$Na_2Ca_2Al_6Si_9O_{30}.8H_2O$
Millerite	NiS
Mordenite	$(Ca,Na_2,K_2)_4Al_8Si_{40}O_{96}.28H_2O$
Natrolite (of Klaproth)	$Na_2Al_2Si_3O_{10}.2H_2O$
Pisanite	$(Fe,Cu)SO_4.7H_2O$
Pyrolusite	MnO_2
Riebeckite	$Na_2Fe^{2}_3Fe^{3}_2Si_8O_{22}(OH)_{22}$
Rosasite	$(Cu,Zn)_2CO_3(OH)_2$
Rutile	TiO_2
Scolecite	$CaAl_2Si_3O_{10}.3H_2O$
Stibnite	Sb_2S_3
Strunzite	$MnFe_2(PO_4)_2(OH)_2.8H_2O$
Ulexite	$NaCaB_5O_9.8H_2O$
Uranophane	$Ca(UO_2)_2Si_2O_7.6H_2O$
Zinckenite	$Pb_6Sb_{14}S_{27}$

Cleaning Water Soluble Minerals

Water soluble minerals present specialized problems where conventional cleaning techniques using water cannot be employed. In addition many such minerals are extremely delicate, being composed of capillary or acicular crystals. Sulphates such as melanterite, chalcanthite, epsomite belong to both categories and are extremely difficult to clean, and they should be handled as little as possible. Blowing may serve to remove particles, but water soluble minerals may sometimes be effectively cleaned by the careful use of non aqueous solvents, such as acetone or carbon tetrachloride. The solvent may be applied using a small paint brush, each particle being picked off, but the careful use of a wash bottle filled with solvent is quite efficient. Great care should be employed in the handling of these solvents: acetone is highly inflammable; and both are toxic, possibly carcinogenic. A fume cupboard should always be used.

Minerals from evaporitic environments pose special cleaning problems. Philbrook (1963, p.31) suggested washing trona, halite, thenardite, glauberite, hanksite, sulphohalite, epsomite and mirabilite in the brine in which the specimens had grown. If brine was not available, she suggested the use of alcohol or a light mineral oil. The great danger of using brine as a cleaning medium is, upon its evaporation, the production of films of white sodium and/or calcium chloride on the specimens. The presence of these films is subsequently masked by the common and unfortunate practise of spraying the specimens with some brand of lacquer. This geatly reduces the value of the material and should not be condoned. Flushing with alcohol is perhaps the safest technique to employ and does in fact assist in the control of deliquescence.

Table No. 2 **Some minerals affected by Water**

Rate of solubility

1 Strongly affected
2 Moderately affected
3 Slightly or slowly affected.

Alum	$KAl(SO_4)_2.12H_2O$	1
Alunogen	$Al_2(SO_4)_3.18H_2O$	1
Amarantite	$Fe^3SO_4OH.3\tfrac{1}{2}H_2O$	Decomposed
Apthiatalite	$NaKSO_4$	1
Apjohnite (Glocker)	$MnAl_2(SO_4)_4.22H_2O$	1
Arsenolite	As_2O_3	3 in hot water
Autunite	$Ca(UO_2)_2(PO_4)_2.12H_2O$	1
Azurite (Beudant)	$Cu_3(CO_3)_2(OH)_2$	Decomposed by hot water
Beyrichite	Ni_3S_4	Decomposed by hot water
Bianchite	$(Zn,Fe)SO_4.6H_2O$	1
Bilinite	$Fe^2Fe^3_2(SO_4)_4.22H_2O$	1
Bischofite (of Ochsenius)	$MgCl_2.6H_2O$	1
Blödite	$Na_2Mg(SO_4)_2.4H_2O$	1
Borax	$Na_2B_4O_7.10H_2O$	1
Botryogen	$MgFe^3(SO_4)_2OH.7H_2O$	3 in hot water
Boussingaultite	$(NH_4)_2Mg(SO_4)_2.6H_2O$	1
Burkeite	$Na_6SO_4(CO_3)_2$	1
Carnallite	$KMgCl_3.6H_2O$	1
Cerussite	$PbCO_3$	Decomposed by hot water
Chalcanthite	$CuSO_4.5H_2O$	1
Colemanite	$Ca_2B_6O_{11}.5H_2O$	3
Copiapite	$R^2Fe^3_4(SO_4)_6(OH)_2.nH_2O$	(1) where R includes Fe^2,Mg,A1, Cu or Na_2
Coquimbite	$Fe_2(SO_4)_3.9H_2O$	1
Cotunnite	$PbCl_2$	1
Cryolite	Na_3AlF_6	3
Cyanochroite	$K_2Cu(SO_4)_2.6H_2O$	1
Darapskite	$Na_3NO_3SO_4.H_4O$	1
Dietrichite	$(Zn,Fe,Mn)Al_2(SO_4)_4.22H_2O$	1
Dietzeïte	$Ca_2(IO_3)_2CrO_4$	2
Dolerophane	Cu_2SO_5	1
Douglasite	$K_2FeCl_4.2H_2O$ (?)	3

Epsomite	$MgSO_4.7H_2O$	1
Erythrosiderite	$K_2FeCl_5.H_2O$	1
Ettringite	$Ca_6Al_2(SO_4)_3(OH)_{12}.26H_2O$	2
Fernandinite	$Ca(VO)_2V_{12}O_{28}.14H_2O$	2
Ferrinatrite	$Na_3Fe^3(SO_4)_3.3H_2O$	3
Gaylussite	$Na_2Ca(CO_3)_2.5H_2O$	3
Glauberite	$Na_2Ca(SO_4)_2$	2
Goslarite	$ZnSO_4.7H_2O$	1
Greenockite	CdS	Powdery varieties readily decomposed by hot water; crystallized varieties less so.
Gypsum	$CaSO_4.2H_2O$	3
Halite	$NaCl$	1
Halotrichite (of (Glocker)	$Fe^2Al_2(SO_4)_4.22H_2O$	1
Hanksite	$Na_{22}K(SO_4)_9(CO_3)_2Cl$	1
Hewettite	$CaV_6O_{16}.9H_2O$	3
Hexahydrite	$MgSO_4.6H_2O$	1
Hieratite	K_2SiF_6	1
Hydrocyanite	$CuSO_4$	1
Ilesite	$(Mn,Zn,Fe)SO_4.4H_2O$	1
Inyoite	$Ca_2B_6O_{11}.13H_2O$	1 in hot water
Kainite	$KMgSO_4Cl.3H_2O$	Decomposed to epsomite and sylvite
Kaliborite	$KMg_2B_{11}O_{19}.15H_2O$	3
Kalinite	$KAl(SO_4)_2.11(?)\ H_2O$	1
Kernite	$Na_2B_4O_7.4H_2O$	2
Kieserite	$MgSO_4.H_2O$	2
Koenenite	$Mg_5Al_2Cl_4(OH)_{12}.2(?)\ H_2O$	Decomposed to scaley precipitate.
Kornelite	$Fe_2(SO_4)_3.7H_2O$	1
Krausite	$KFe^3(SO_4)_2.H_2O$	Slowly decomposed.
Kremersite	$(K,NH_4)_2FeCl_5.H_2O$	1
Kröhnkite	$Na_2Cu(SO_4)_2.2H_2O$	1

Langbeinite	$K_2Mg_2(SO_4)_3$	3
Lanthanite	$(Ca,Ce)_2(CO_3)_3.9H_2O$	Decomposed by hot water.
Larnite	Ca_2SiO_4	2
Lautarite	$Ca(IO_3)_2$	3
Lecontite	$Na(NH_4,K)SO_4.2H_2O$	1
Leonite	$K_2Mg(SO_4)_2.4H_2O$	1
Löweite	$Na_2Mg(SO_4)_2.2.5H_2O$	1
Malachite	$Cu_2CO_3(OH)_2$	Decomposed by hot water.
Mallardite	$MnSO_4.7H_2O$	1
Mascagnite	$(NH_4)_2SO_4$	1
Melanterite	$FeSO_4.7H_2O$	1
Mendozite	$NaAl(SO_4)_2.11\ (?)H_2O$	1
Metahewettite	$CaV_6O_{16}.9H_2O$	3
Metarossite	$CaV_2O_6.2H_2O$	2
Metavoltine (of Blaas)	$K_4Na_3Fe^2Fe^3{}_5(SO_4)_{12}.16H_2O$	3
Millerite	NiS	Decomposed by hot water.
Minasragrite	$(VO)_2H_2(SO_4)_3.15H_2O$	1
Mirabilite	$Na_2SO_4.10H_2O$	1
Misenite	$K_8H_6(SO_4)_7$	1
Mitscherlichite	$K_2CuCl_4.2H_2O$	1
Morenosite	$NiSO_4.7H_2O$	1
Nahcolite	$NaHCO_3$	1
Natrochalcite	$NaCu_2(SO_4)_2OH.H_2O$	2
Natron	$Na_2CO_3.10H_2O$	1
Nitratine	$NaNO_3$	1
Nitre	KNO_3	1
Nitrobarite	$Ba(NO_3)_2$	1
Nitrocalcite	$Ca(NO_3)_2.nH_2O$	1
Nitromagnesite	$Mg(NO_3)_2.6H_2O$	1
Orpiment	As_2S_3	Soluble (3) in hot water.
Oxammite	$(NH_4)_2C_2O_4.H_2O$	1

Pascoite	$Ca_2V_6O_{17}.11(?)H_2O$	2
Phillipite	$Cu_3Fe_2(SO_4)_6.40H_2O$	1
Pickeringite	$MgAl_2(SO_4)_4.22H_2O$	1
Picromerite	$K_2Mg(SO_4)_2.6H_2O$	1
Pintadoite	$Ca_2V_2O_7.9H_2O$	2
Pisanite	$(Fe,Cu)SO_4.7H_2O$	1
Polyhalite	$K_2MgCa_2(SO_4)_4.2H_2O$	Decomposed with separation of gypsum
Rinneïte	$K_3NaFeCl_6$	1
Römerite	$Fe^2Fe^3_2(SO_4)_4.12H_2O$	1
Rossite	$CaV_2O_6.4H_2O$	3
Sal-ammoniac	NH_4Cl	1
Sassolite	$B(OH)_3$	1
Schairerite	$Na_3SO_4(F,Cl)$	2
Schröckingerite	$NaCa_3UO_2SO_4(CO_3)_3F.10H_2O$	1
Sideronatrite	$Na_3Fe^3(SO_4)_3.3H_2O$	Soluble in hot water with decomposition
Siderotil	$FeSO_4.H_2O$	1
Sulfoborite	$Mg_3SO_4B_2O_5.4.5H_2O$ (?)	Decomposed in water.
Sulphohalite	$Na_6(SO_4)_2ClF$	3
Sylvine	KCl	1
Syngenite	$K_2Ca(SO_4)_2.H_2O$	3 with separation of gypsum.
Szomolnokite	$FeSO_4.H_2O$	2 with formation of brown solution
Tachhydrite	$CaMg_2Cl_6.12H_2O$	1
Taylorite (of Dana)	$(K,NH_4)_2SO_4$	1
Teschemacherite	$(NH_4)HCO_3$	1
Thenardite	Na_2SO_4	2
Thermonatrite	$Na_2CO_3.H_2O$	1
Tincalconite	$Na_2B_4O_7.5H_2O$	1
Trona	$Na_3H(CO_3)_2.2H_2O$	1
Tschermigite	$NH_4Al(SO_4)_2.12H_2O$	1

Ulexite	$NaCaB_5O_9.8H_2O$	2
Vanthoffite	$Na_6Mg(SO_4)_4$	2
Villiaumite	NaF	1
Voltaite	$HK_2Fe^{2}_4(Fe,Al)_3(SO_4)_{10}.13H_2O$	Decomposes with yellow precipitate
Zinc-copper-melanterite	$(Zn,CU)SO_4.7H_2O$	1

As a guide, Table 2 provides a list of minerals which are affected by water to some degree of solubility or decomposition. The collector may comment on the unlikely possibility of having to deal with many of the species listed in the Table. This may have been the case forty years ago, but the recent surge of interest in mineralogy has made the likelihood a reality. Many amateur collectors have widened the scope of their collecting to include many species in the Table which could cause problems.

In addition, the number of mineral species described annually is increasing at a greater and greater rate. For example, the period between 1960-1973 saw the accepted introduction of 575 new species (Mandarino, 1977, p.2). Because of this explosion in the growth of the Mineral Kingdom, many collectors are becoming specialists in certain aspects of mineralogy. Some may, for example, restrict their activities to collecting zeolites, and amass a fine collection of them. Others may devote their energies to collecting from a single locality such as a mine. This specialization inevitably leads to the acquisition of minerals with stability problems, including solubility in water.

Cleaning Absorbent and Porous Minerals.

Many minerals are friable or physically disintegrate if immersed in water. They are usually found in damp situations, and many cannot survive out of them. Amongst this group are those subject to efflorescence, but this form of instability is examined in detail in a later section. There are other species which once preserved, will remain so if simple precautions are taken.

Any mineral collected from a wet geological environment must be dried carefully, but porous minerals and those liable to dissolution when immersed in water must be dried slowly under controlled conditions.

Hydrozincite for example, when found, perhaps coating the walls of an old adit, will be soft, wet and earthy in appearance. To prevent the development of dessication cracks on its surfaces and, in certain cases, complete dissolution, it must be allowed to dry very slowly, either by application of light-weight cloths spray-dampened by distilled water at measured time intervals or by immersion in a controlled atmosphere such as in a valved dessicator. Such specimens, once dry, must remain so and any cleaning necessary subsequently must be mechanical and dry. Their storage in average centrally-heated conditions usually gives no trouble.

Special care should be taken in the curation of all varieties of opal. Opal from some localities, due to its absorbent nature, is prone to dehydration, followed by cracking. All opal should therefore be stored in glass jars filled with glycerin or silicone fluid.

Table No. 3 List of some absorbent and porous minerals.

Aluminite	$Al_2SO_4(OH)_4.7H_2O$
Chloropal	Silicate of Fe^3
Chrysocolla	$CuSiO_3.2H_2O$
Cimolite	$Al_4Si_9O_{24}.6H_2O$
Gibbsite (of Torrey)	$Al(OH)_3$
Halloysite (of Berthier)	$Al_2Si_2O_5(OH)_4.2H_2O$

Hydrozincite	$Zn_5(CO_3)_2(OH)_6$
Illite	$K_{2\text{-}3}Al_{11}Si_{12\text{-}13}O_{35\text{-}36}(OH)_{12\text{-}13}$
Limonite	Hydrated oxide of Fe^3
Kaolinite Group < Nacrite Dickite	$Al_2Si_2O_5(OH)_4$
Metarossite	$CaV_2O_6.2H_2O$
Montmorillonite	$R._{0.33}(Al,Mg)_2Si_4O_{10}(OH)_2.nH_2O$, where R. includes Na., K., Mg2, Ca2.
Opal	$SiO_2.nH_2O$
Palygorskite	$(Mg,Al)_5(Si,Al)_8O_{20}(OH)_2.8H_2O$
Pyrolusite	MnO_2
Sal-ammoniac	NH_4Cl
Saponite (of Svanberg)	Aluminosilicate of Mg
Sassolite	$B(OH)_3$
Scarbroite	A clay mineral containing c.44% $Al_2O_3$and c.6% SiO_2
Searlesite	$NaBSi_2O_6.H_2O$
Sepiolite	$Mg_3Si_4O_{11}.5H_2O$
Sideronatrite	$Na_2Fe^3(SO_4)_2OH.3H_2O$
Turquoise	$CuAl_6(PO_4)_4(OH)_8.5H_2O$
Valentinite	Sb_2O_3

Cleaning Well Cleaved Minerals.

Minerals with strongly developed cleavage should never be immersed in liquids, especially the more volatile liquids. The perfect basal cleavage of micas, for example, allows the rapid infiltration of liquids, which have even been known to burst specimens. Dusting, with a soft animal hair brush, camel preferably, is the only safe technique in this case.

Similar limitations apply to the immersion of crystals of gypsum, variety selenite, in water. The perfect cleavage on {010} allows ready infiltration. For this reason selenite should never be washed in solutions of soap or detergent, where films of soap, or precipitates formed by soap in hard water, are deposited along the cleavage planes producing an opalescent or cloudy effect to normally glass-clear material.

Removal of oil and tar staining.

The removal of contaminating oil and other hydrocarbon compounds from the surfaces of minerals is usually straight forward. It should be remembered that naturally occurring hydrocarbon compounds, such as asphalt, constitute an important part of the paragenesis of some mineral occurrences, and their preservation as such should be observed.

On the other hand, hydrocarbon contamination of geological specimens, from coastal sections in particular, is a common phenomenon today and demands the skill of the collector as a first-step cleaning requirement.

As it is usually quite impossible to determine the chemistry of the contaminating hydrocarbon compound, the determination of which solvent to use for its removal must be a matter of experiment. A surprising number of hydrocarbons are readily soluble in acetone, the use of which has no undesirable effects on the mineral being cleaned. Benzene, carbon tetrachloride and ethyl alcohol are equally effective solvents.

The mineral should be immersed in whichever solvent has been selected as the most effective and allowed to remain there until the contamination has been removed. To prevent evaporation of the solvent it is advantageous to conduct the operation in a closed vessel. Agitation of the liquid from time to time ensures uniform action of the solvent. The whole exercise should be conducted in a fume cupboard or before an open window to minimise the toxic effects of the organic fumes.

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Articles for publication in the journal are welcomed from both professional and amateur mineralogists, and should be submitted as the following:—

1. Articles for publication should be typed and double-spaced on A4 (210 x 297mm) paper. For ease of editing, standard type-face should be used.
2. Figure and plate captions should be typed together. Photographs of minerals should be accompanied by the following information:
    a) Name of species
    b) Locality details.
    c) Size of specimen or of an individual face (in mm).
    d) Colour. (If possible using the Methuen Handbook of Colour).
    e) The name of the owner of the mineral.
    f) The name of the photographer.
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    b) Introduction.

c) Geology of the locality/ies.

d) History of mining or of specimen acquisition.

e) Description of minerals referred to.

f) Description of mineralogical paragenesis of the mineral body/ies.

g) Discussion.

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